# CEREAL SCIENCE *today*

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NOVEMBER 1956 VOLUME 1 • NUMBER 5



AN OFFICIAL PUBLICATION
OF THE
AMERICAN ASSOCIATION
OF CEREAL CHEMISTS

OF INTEREST THIS MONTH

FAMILY FOOD SPENDING

AMINO ACID SUPPLEMENTATION

# White Flour in the U.S.A.—

## Enriched* with Vitamins and Iron for Better Nutrition

*by* Science Writer

*This article is one of a series devoted to the enrichment of family white flour, white bread and rolls, corn meal and grits, macaroni products and white rice.*


The enrichment of family white flour with thiamine, riboflavin, niacin and iron by American millers is a major success. It has made great contributions to better health in the United States by improving a staple food.

Since the start of the program in 1941 by millers, voluntarily, the evidence is conclusive that enrichment not only has reduced the number of cases of certain dietary diseases but also is promoting the mental and physical vigor and well-being of the U. S. population generally. Because of its demonstrated value, the principle and practice of enrichment have been applied to other foods made from grains: corn meal and grits, white rice, macaroni, spaghetti, noodles, pastina, farina—and, of course, to white bread and rolls.

Doctors and diet experts have long supported white flour enrichment. The Council on Foods and Nutrition of the American Medical Association and the Food and Nutrition Board of the National Research Council are on record as endorsing the practice.

The legislatures of a majority of the States plus Hawaii and Puerto Rico have enacted laws which make mandatory the enrichment of all family white flour, as well as white bread, sold commercially in those areas.

American homemakers, too, favor foods they know to be enriched—a fact demonstrated by surveys. They look for these words on package labels: "Enriched with vitamins and iron for better nutrition."

### What Is Enrichment?

It's an axiom in the milling industry that consumers want beautifully fine, white flour. When wheat is milled and processed to get the white flour which the public demands, vitamin and mineral values are unavoidably lost.

Enrichment restores to white flour the following important vitamin and mineral factors: thiamine, riboflavin, niacin and iron. Calcium also may be added as an optional ingredient. The process is simple and inexpensive. A mixture of the vitamins and iron is fed into the flour stream during processing. This insures that the enriching ingredients are spread evenly throughout the flour.

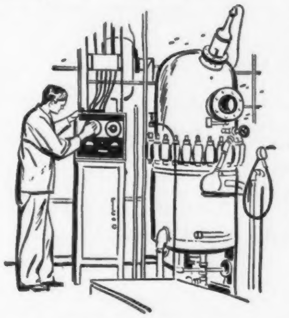
The U. S. Food and Drug Administration has established standards which white flour must meet to be properly labeled enriched. The requirements, in milligrams per pound, are:

| | *Min.* | *Max.* |
|---|---|---|
| **Thiamine** (vitamin $B_1$) | 2.0 | 2.5 |
| **Riboflavin** (vitamin $B_2$) | 1.2 | 1.5 |
| **Niacin** (another "B" vitamin) | 16.0 | 20.0 |
| **Iron** | 13.0 | 16.5 |

(In Canada, too, the same standards have been set for enriched white flour through the amendment of the Food and Drugs Act.)

### Vitamins Are Made

The science of chemistry is so advanced these days that many of Nature's complex substances can be "duplicated" in the laboratory.



This has happened with many vitamins. First, the chemical composition is learned. Second, the pure substance is isolated. Third, a "duplicate" is made by synthesis. And fourth, the laboratory techniques are extended to large scale operation.

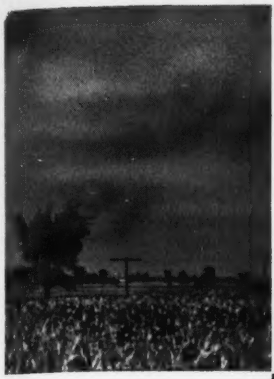
The manufactured "duplicate" is identical chemically and in biological activity with Nature's own product. A vitamin is still a vitamin regardless of its source. So efficient is large scale manufacturing that vitamins are sold at a lower cost than if they were extracted from natural sources.

The Hoffmann-La Roche people make top quality vitamins actually by the tons. To do this they use amazingly complex processes with scientific production controls and the latest equipment which fill buildings each a city block square and many stories high.

Reprints of this article, and all others in this series are available without charge. Please send your request to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

*The watermills are gone. Today's needs require today's methods. How sensible it is that millers across the nation restore health-giving vitamins and minerals through enrichment.*

*Webster's Merriam Collegiate Dictionary includes this definition of "enrich": "to improve (a food) in nutritive value by addition in processing of vitamins and minerals".



VOLUME 1 • NUMBER 5 • NOVEMBER 1956

# CEREAL SCIENCE *today*

## FEATURES



## TECHNICAL SECTION



## DEPARTMENTS



## STAFF



COVER: Small "experimental" mills such as this one imported from Switzerland are used in the milling industry to test samples of wheat for flour-making qualities before selections are made for blending in mass production. Photo courtesy Pillsbury Mills, Inc.



*CEREAL SCIENCE Today* is published ten times per year (monthly except June and August) by the American Association of Cereal Chemists, from 500 South 5th Street, Minneapolis 15, Minnesota. Editorial Headquarters and Circulation Department: University Farm, St. Paul 1, Minn. Advertising Office: 360 N. Michigan Ave., Chicago 1, Ill. Entered as second class matter at the post office at Minneapolis, Minn., under the Act of August 24, 1912.
The American Association of Cereal Chemists assumes no responsibility for the statements and opinions advanced by contributors to its publications. Views expressed in the editorials are those of the editors and do not necessarily represent the official position of the American Association of Cereal Chemists.
Subscription rates: 1 year, $3.00; 2 years, $5.00; 3 years, $7.00. Foreign postage: $1.00 per year extra. Back issues available on request. Single copies: 35 cents.
CHANGE OF ADDRESS: Notify Circulation Department, American Association of Cereal Chemists, University Farm, St. Paul 1, Minn. Include both old and new addresses and postal zone number, if any.

# Editorial

THE CONTINUING ACCELERATION of pure and applied research during the first half of the twentieth century has led to a rapid increase in knowledge. Science, like the amoeba, increases by division and redivision; as the scope of each branch of knowledge increases, new sciences are born and each advance results in a further splintering. This increased specialization is both the strength and weakness of science. It is inevitable that we must have specialists with their own particular techniques for furthering the advance of knowledge, but specialization is detrimental to the unity of science and its coordination. It is not surprising, therefore, that the lone worker is being replaced by a carefully chosen group of scientists whose talents dovetail together.

This modern research pattern which links fundamental theory and its application is being applied in ever-widening fields and is resulting in a closer tie between science and technology. Cereal research laboratories are being staffed with chemists who have specialized in some fundamental branch of chemistry or some phase of biochemistry, with mathematicians, with physicists, and with micro-biologists. Scientists trained in these different areas are combining their skills to make a joint attack on cereal problems which cannot be solved by employing the techniques of any one branch of science.

The vast majority of cereal chemists are concerned with applied research and with quality control, activities which are of vital importance to the cereal industries. Industrial requirements are always putting new questions to science and have an important influence on basic research. On the other hand, the progress of science continually brings new life to old industries and gives birth to new ones, so that cereal chemistry and technology are closely interwoven.

It has aptly been said that the quick harvest of applied science is the usable process, the medicine and the machine whereas the shy fruit of pure science is understanding.

W. F. GEDDES

TODAY'S TRENDS AND HABITS IN

# Family Spending For Food

By Faith Clark*

TODAY WE IN the United States are in an era of high food spending. The average expenditure for food, as reported by the Department of Commerce (including alcoholic beverages and the money value of food produced and consumed on farms), is estimated at almost $450 per capita for the year 1955 — about $1.25 a person a day. This is about 3⅓ times what it was in the prewar period. Much of this, of course, is because of price increases, but even after this allowance, food expenditures are about 1½ times what they were in 1935–1939.

Meals and snacks away from home account for some of this increase, although perhaps not so much as some people have thought. Such meals and beverages now make up about one-fifth of the $450 total; in the 1930's they made up only one-sixth. The highest proportion (one-fourth) came near the end of World War II when people were traveling around a great deal and eating in restaurants because of rationing. Nonhome expenditures have increased at a somewhat higher rate than those for food to be prepared and served at home. The 1955 figure for meals and beverages eaten "out" is about four times the 1935–1939 average, compared with a threefold increase in expenditures for food used in homes.

The greater increase for out-of-the home food and beverages was to be expected, considering the marked increase in incomes over this period. Surveys have shown that amounts spent on food eaten "out" increase with income at a much greater rate than do those for food prepared and served at home. A 10% increase in family incomes may result in a 10% increase in nonhome food expenditures, but only a 3 or 4% increase in spending for home-consumed food. In the economist's language, expenditures for food away from home are said to be elastic; those for food at home, inelastic. When incomes increase markedly, it is those items in the family budget that are income-elastic that usually increase the most, percentagewise. Those that are inelastic increase the least. Food expenditures as a whole are inelastic and hence have increased relatively less than some other items in the family budget, notably automobiles and household equipment.

★ ★ ★

*There have been pronounced changes in the eating habits of the American public since World War I, and particularly since the end of World War II. In terms of nutrition, these changes have had several significant results: A trend toward fewer calories per person; an increase in the proportion of calories from fat; an increase in some of the nutrients such as calcium, riboflavin, and vitamins A &C because of more milk in the diet and more green leafy vegetamles; more iron and B-vitamins because of the enrichment of white bread and flour.*

★ ★ ★

#### Income-Elastic Foods

Some foods are more income-elastic than others. Spending for most foods increases somewhat with income. For a few, however, it actually decreases as income rises. Generally, the higher the family income, the less flour, meal, and cereals are used. More bakery products — bread, crackers, rolls, pies, cakes, etc. — are purchased, though spending for these items does not increase with income nearly as much as that for many other foods. The net effect for grain products as a whole — both flour and cereal products used at home and the bakery products purchased for use at home — is that the physical quantities consumed by people with higher incomes are a little smaller than those of people with lower incomes. Expenditures remain about the same.

In general, foods that have had a lot of processing are more income-elastic than those with relatively little. With higher incomes, women can afford to buy their food with some of the processing already done for them. More women are working, and with higher family incomes they are paying to have done outside the home some of the tedious chores involved in preparing meals. In March 1955 about 28% of married women in the United States were working outside their homes. In 1948 22% were doing so and in 1940, only 15%.

#### The "Out-of-the-Kitchen" Trend

What share of the food budget is allotted to ready-processed foods? That depends, of course, on what you call ready-processed. Some time ago we made a calculation based on a survey of food consumption of urban families in 1948. The proportion of the budget going to these processed foods was about one-fourth. In this we included bread, baked goods, mixes, ready-to-eat cereals; canned and ready-to-eat meat, poultry, and fish; canned and frozen vegetables and fruits and juices; prepared dessert powders and other sweets; soups and other prepared or partially prepared dishes; and pickles, jams,

* Head, Food Consumption Section, Household Economics Research Branch, U.S. Department of Agriculture, Agricultural Research Service, Washington 25, D.C. Presented at the 41st annual meeting, New York, May 1956.

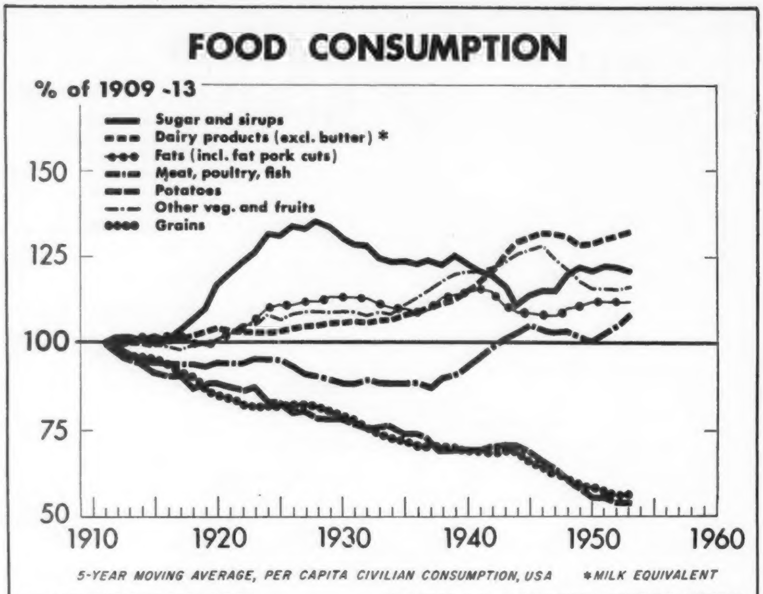


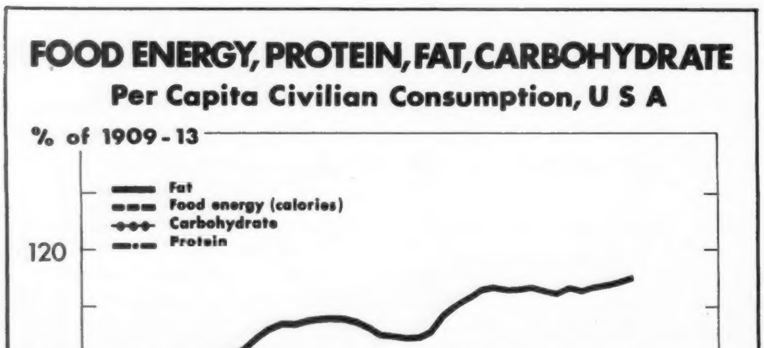

CHART NO. 1

jellies, and salad dressings. Many of these items have been on the market for a number of years, but 50 or 60 years ago most housewives made or prepared them at home. The proportion bought ready-processed now — 1956 — may be somewhat higher than the one-fourth estimated for 1948.

We hear so much about the passing of food preparation and processing from the kitchen to commercial hands — such as the TV dinner — that we might be inclined to think of it as a new development. Actually, some of the biggest changes are behind us — if we measure bigness in terms of the impact on work in the home. Baking of bread and canning of fruits and vegetables are examples.

Recent household surveys compared with earlier ones illustrated this out-of-the-kitchen trend with respect to home baking. During a week's survey in the North Central region in 1952, practically all farm families (91%) used some purchased bread. Only about 25% made any bread at home. Roughly comparable data for 1936 indicated that only two-thirds of the farm households used purchased bread then. The number baking their own bread was not determined, but undoubtedly it was much higher than the 25% who made some of their own bread at home in 1952. In urban homes, few homemakers now bake their own bread.

CHART NO. 2




### Home Preparation Still Counts

With all the talk about convenience foods, we are apt to overlook the fact that, partially or completely prepared purchased foods notwithstanding, a large share of the family food budget still goes for items that require considerable preparation or are ingredients of mixtures that by choice are time-consuming to make. For example, meat, poultry, and fish (excluding canned and ready-to-eat items) take 26% of the food budget; milk, cream, and cheese, 14%; eggs, 4%; fresh vegetables, including potatoes, and fresh fruits, 14%; and fats and sugars, 10%. These items add to about 70% of the family market basket, only about 3% going to flour and cereals. In the South, the proportion of the food dollar spent for flour, meal, and cereals is a little higher than in the North (about 5% in cities, more on farms).

### Trends and Their Significance

As part of the Department's food and agriculture program, we in Home Economics Research undertake periodic reviews of the food and nutrition situation in the United States. Calculations of the nutritive value of per-capita food consumption show some results of trends in food consumption over the years. As many of you know, these data on trends show that each of us now eats more of the dairy products (except butter) and of eggs, poultry, and many of the vegetables and fruits, than people did at the beginning of the century, but we eat fewer potatoes and grain products. Consumption of meat per capita is about the same now or a little higher than it was before the first World War. As indicated in Chart 1, more fats and sugar are consumed than in the early part of the century, although we use less sugar than we did in the years between wars.

In terms of nutrition, these changes have several significant results. First, there has been a slight trend toward

fewer calories per person (Chart 2). The increased consumption of some foods has been more than compensated, in calories, by smaller consumption of others, chiefly grain products and potatoes. During the past 40 or 50 years, we have had a shift in the kind of work people do, a movement of population from farms to cities, widespread use of many labor-saving devices in factories, on farms, and in homes, and an increasing proportion of elderly persons in our population. So the trend toward fewer calories is related to a lower average need for food energy. We also have become increasingly aware of the need to control body weight.

The steady increase in the share of total calories derived from fat is another trend in the national diet. There has been some increase in grams of fat consumed per person and considerable decrease in grams of carbohydrate; and because total calories are down, the percentage from fat has increased rather markedly in 40 years, from about 32% to 40%. At the same time the percentage of calories from protein has remained remarkably constant, around 11%. Whether the shift in the source of our calories—more from fat, less from carbohydrate—is desirable nutritionally is questionable and is a subject needing much more research.

Largely because of our increased use of milk over the years, there have been long-term increases in the calcium and riboflavin content of the national diet. Intake of vitamins A and C (ascorbic acid) also has increased because of greater use of leafy green and yellow vegetables and products, such as citrus fruit and tomatoes, that are rich in vitamin C. Supplies of iron and the B vitamins (thiamine and niacin) dropped from the early 1900's to the mid-1930's, and then increased as a result of the rise in meat consumption and the enrichment of white bread and flour. Present-day levels of these nutrients, however, are lower than they were in the mid-1940's (see Charts 3 and 4).

Today, Americans have at their command a varied and abundant food supply. Some groups in the population, however, still do not choose meals that provide recommended amounts of several nutrients. Dietary surveys show that those whose diets are most in need of improvement are families with low incomes, large families, and those in which the homemaker has the least formal education. The nutrient most likely to be supplied in smaller-than-recommended quantities is calcium. Also likely to be low are vitamin C and the B-vitamins — thiamine, riboflavin, and niacin. Rural diets in some seasons may also be low in vitamin A.

Differences in quality of diet due to economic limitations are not so great as formerly, but problems of getting good diets on low incomes still merit attention.

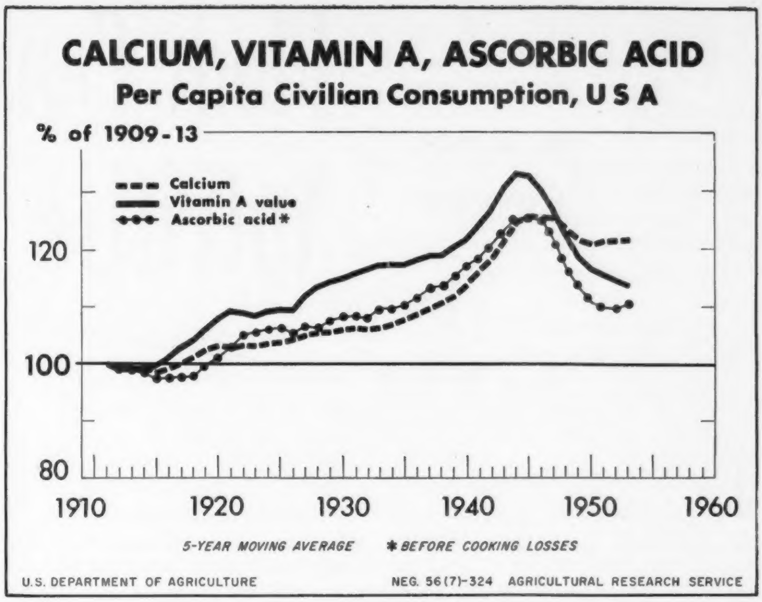
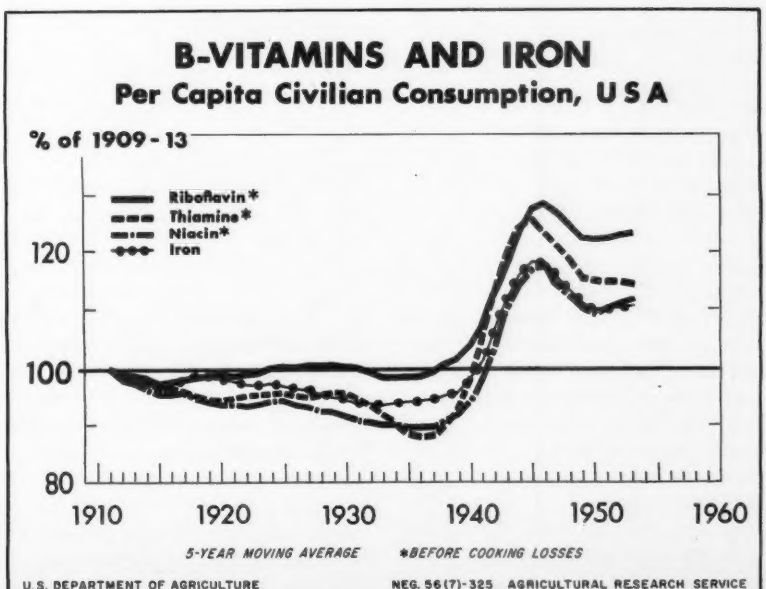



CHART NO. 3

**Results of 1955 Survey Awaited**

A food-consumption survey made in 1955 will bring us up to date on the dietary situation in households in the United States. It is the first nationwide survey (rural as well as urban) made since 1942. The results are awaited with interest by many groups — marketing people and home economists as well as program and policy makers in the U.S.D.A. It is hoped that reports from the survey will be ready late in 1956.

CHART NO. 4



REPORT OF THE BRITISH PANEL ON

# Flour Composition and Nutritive Value

By D. W. Kent-Jones*

THE MILLING AND baking industries have been awaiting with ill-concealed interest the publication of this report and it is a matter of great concern not only to Great Britain, but also to many other countries. However, to appreciate the position it is necessary to know something of the background and of the events which have led up to the appointment of the Panel that was presided over by an eminent medical man, Sir Henry Cohen, who, in the recent Honors List, has been made a Baron, i.e., a Peer.

During the war it was necessary, because of the supply position consequent upon the submarine menace, to have bread made from long-extraction flour. In general, this flour was around 85% extraction and, thanks to the skill of the miller, it was a flour and not a meal and it had considerably less fiber than was at one time thought possible. It had a natural high-vitamin content and this pleased many nutritional authorities. Research work, mainly in the Research Association of the British Flour Millers, directed by T. Moran, suggested that it might be possible to make a whiter flour of about 80% extraction that would still be high in vitamin $B_1$, since the bulk of this vitamin was found to be located in 1.5% of the grain, i.e., the scutellum. At the end of the war there was a conference on the "Post-War Loaf" between the nutritional authorities, such as the Medical Research Council, and the millers and bakers. They issued their report in 1945. They agreed that flour should reach certain nutritional levels (the so-called "token" nutrients), namely, 0.24 mg. vitamin $B_1$, 1.60 mg. nicotinic acid, and 1.65 mg. iron per 100 g.

It was considered that this standard could be reached by milling to 80% extraction and, for the time being, this long-extraction flour was the only one permitted. In 1953, a new Flour Order, No. 1282, permitted also the use of white flour of lower extraction, provided that this was fortified to reach the nutritional standard already given and laid down in the Post-War Loaf Report. However, the bread from the National (80%) flour was subsidized, while white bread was not. Although the Post-War Loaf Report was unanimous, it was only so on the promise that the question of enrichment should be considered. Indeed, it was promised that certain questions would be the object of further study, and the first of these was "how long-extraction flour suitably reinforced with the 'token' nutrients compares from a nutritional point of view with high-extraction obtained wholly from the wheat grain. In this connection, consideration will, of course, have to be given to information which may be available as to the results of the widespread use of reinforced flour in the United States."

This promise was kept, and the Medical Research Council organized, in 1947, what came to be known as the Widdowson-McCance experiment, made on children in orphanages in Germany. In this experiment the children, in general, had the poor rations then prevalent in Germany, but these were supplemented by bread and other products from five types of flour, of which unlimited amounts were permitted. The five different experimental flours were: (1) 100% extraction; (2) 85% extraction; (3) 70% extraction (white flour); (4) 70% flour enriched with thiamine, riboflavin, nicotinic acid, and iron up to the amounts of these substances present in the 100% flour; and (5) 70% flour enriched with the same substances up to the amounts present in 85% extraction flour.

It is not possible to give all the details of the tests, especially as these are well known and have been set out in detail in the Medical Research Council Special Report Series 287, which, incidentally, was not published until 1954. The results were to most people most unexpected. It was thought that the unfortunate children having the white flour would suffer ill-health, and precautions were taken to see that the experiment was not continued so as to cause serious upset.

Perhaps the best method of summarizing the report is to quote extracts from the report itself:

> "Two outstanding conclusions may be drawn from these experiments. Firstly, no differences either in growth or health could be detected between the groups of children eating the various kinds of bread; secondly, all the children did remarkably well on these diets which by commonly accepted standards would be considered very poor. The latter point is often brought out even more clearly when all the children in each orphanage are considered together, irrespective of the kind of bread they were eating; in the presentation of the results, therefore, the progress of all the children together is considered as well as the progress of the separate groups of children eating the different breads.
>
> "One of the most striking findings in these investigations, and perhaps the most unexpected one, was the remarkable way in which the general condition of all the children at Duisburg improved dur-

* Analytical consulting chemist, The Laboratories, Dudden Hill Lane, Willesden, London, England.

ing the year of the experiment."

It was stated also in the Report that distinguished medical visitors "saw the children towards the end of the experiments, and all agreed that they were in excellent physical shape. They were unable to pick out individual children as belonging to a particular bread group. At no time was there any digestive upset which might have been attributed to the diet." The report continues:

"At the time when the experiment began, it was not anticipated that all the children would improve as much as they did. In fact, it was thought that some might deteriorate. The standards used for clinical gradings, therefore, were chosen in relation to the general condition of the children in the orphanage at the first examination, so that the middle class, B, contained the largest number of children and there would be room for improvement or deterioration. The children improved at both homes, and it would be impossible for these results to say that the group on any one bread did better than any other. All improved equally well as regards the special points noted at the clinical examination, such as muscular development and tone, subcutaneous fat, hyperkeratosis, and skin sepsis.

"During the experimental period in both orphanages the increase in caries was trifling in all the bread groups, and it may be concluded that the experimental diets did not affect the teeth adversely."

With this information before them, the Government might easily have considered that there was no justification for subsidizing bread made from long-extraction flour and not bread made from enriched flour, but controversy still raged. To settle the matter the Government asked the President of the Royal Society to appoint an impartial enquiry which was known as the Cohen Committee, or the Panel on Composition and Nutritive Value of Flour.

#### The Panel

The Panel consisted of Professor Sir Henry Cohen, M.D., D.Sc., LL.D., F.R.C.P., J.P. (Chairman); A. C. Chibnall, Esq., Ph.D., Sc.D., F.R.S.; Professor J. H. Gaddum, Sc.D., M.R.C.S., L.R.C.P., F.R.S.; Professor R. A. Morton, Ph.D., D.Sc., F.R.I.C., F.R.S.; and Professor L. J. Witts, D.M., Sc.D., F.R.C.P.

The terms of reference were: "In the light of the scientific and medical evidence now available, (1) to determine the differences in composition and nutritive value between:

(a) National flour as defined in the Flour Order, 1953;
(b) flour of extraction rates less than National flour as defined in the Flour Order, 1953, to which the three token nutrients have been restored; and
(c) flour of extraction rates less than National flour as defined in the Flour Order, 1953, to which the three token nutrients have not been restored;

and (2) to advise whether any such differences are significant from the point of view of the health of the population."

Flour Order 1282 of 1953 defined National Flour as follows:

" 'National Flour' means flour complying with the following conditions: (1) It shall contain the maximum quantity of wheat germ which, having regard to the type of milling, can be included in such flour; (2) it shall not include any coarse or added bran; and (3) it shall consist of wheat flour and shall either be of 80% extraction or shall be of substantially the same nature and contain substantially the same quantities and proportions of constituents as flour of 80% extraction."

#### How the Enquiry Was Conducted

Evidence was presented in writing, and those presenting what was perhaps considered the most authentic received the evidence of others judged to be in a similar category. The author, for example, presented evidence and was allowed to see that put forward by the millers, bakers, the Medical Research Council, and the Scientific Advisers of the Ministries concerned. Finally, a few of us were interviewed when questions were asked and opinions offered. We stressed the independent evidence we had given in the Cantor lectures to the Royal Society of Arts in 1950, and the value of the Newfoundland experiment of 1948.

We have reason to believe that our views on the $B_1$ content of the white flour and of the urinary excretions of the children consuming this flour may have interested and influenced the Panel. We stressed that the only real criticism we had of the Widdowson-McCance Report was that, for the reasons we had given, it was not sound with respect to unenriched white flour and that fortification was essential. It is also interesting to us and we believe to the trade, to note that grade color figures associated with us were quoted.

We were cross-examined on the helpful tables issued by the Ministry of Food in their Annual Surveys, since we had said that these left us with the impression that today most people, save perhaps old-age pensioners, did reach the levels of nutrition advocated by the British Medical Association. We supported this by quoting certain tables, but it was stressed that the standard might fall below that desirable in certain wage groups and in the poorest group, families with many children. We replied that it seemed drastic to change the nature of the bread for *all* the nation in order to ensure that a small section of the public did reach in full and in every respect the British Medical Association's standard.

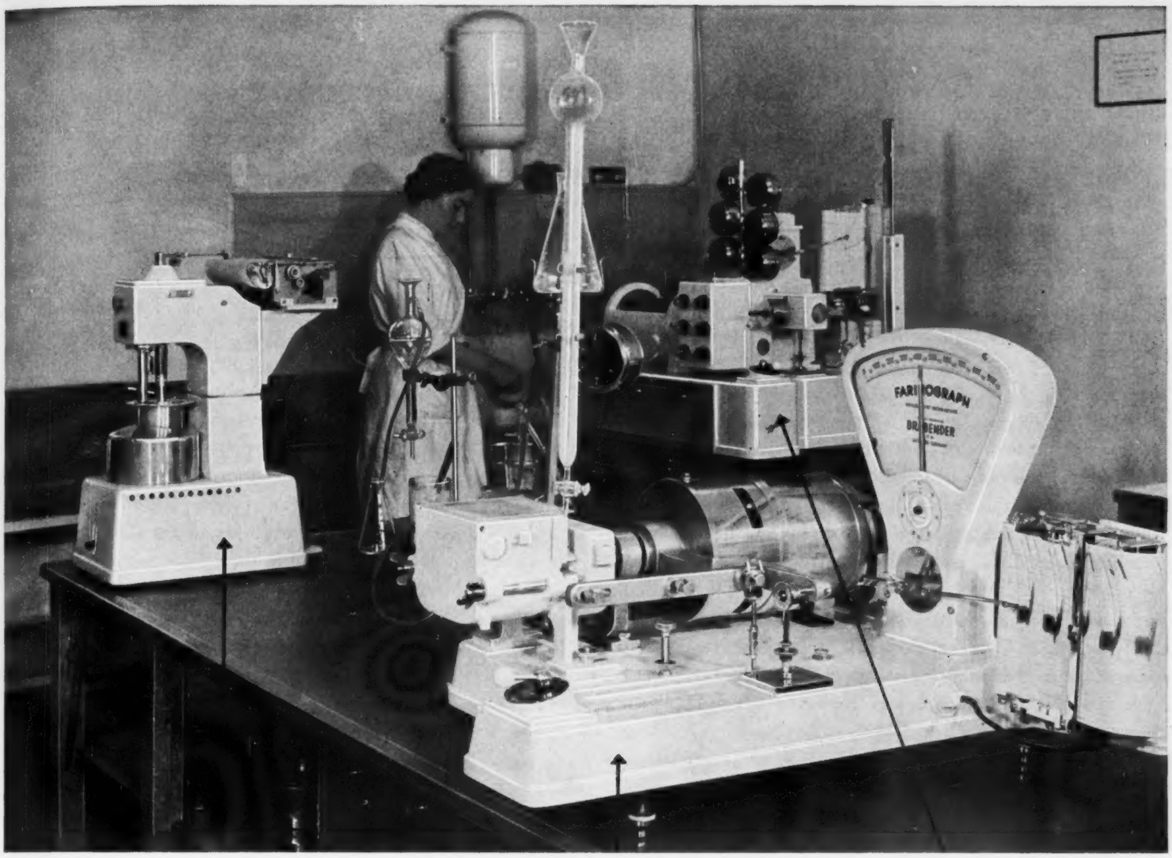
While the millers and bakers and ourselves favored enrichment, the Medical Research Council opposed this and urged what they considered to be the greater nutritional value of long-extraction flour because of the presence of greater amounts of pyridoxin, pantothenic acid, folic acid, and biotin. Indeed, the crux of the matter rested largely on whether differences in these matters between enriched white flour and long-extraction flour, as parts of a modern mixed diet, were significant. Conclusions on this point were:

"The Panel's review of the relevant literature leads them to believe that, in spite of weighty opinion to the contrary, a lowering of the extraction rate from 80% to 70% is very unlikely to lead to any nutritional disturbance from lack of these vitamins."

#### General Conclusions

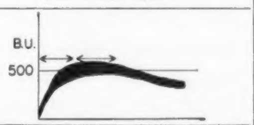
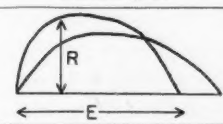
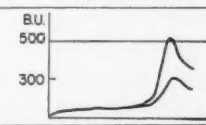
The findings of this important enquiry of experts, who had shown no previous bias on the subject one way or another but who made their decision on the evidence presented to them, was quite definite. They re-

*(Please turn to page 172)*



**Brabender Amylograph  Brabender Farinograph  Brabender Extensigraf**

**A Typical Brabender Flour and Dough Testing Laboratory Using *the Three-Phase Conception of* Baking Performance**

| | I PHASE<br>Dough Mixing | II PHASE<br>Fermentation & Machining | III PHASE<br>Oven Period |
|---|---|---|---|
| **Measuring Instr. Used** | ***Farinograph*** | ***Extensigraf*** | ***Amylograph*** |
| Type of Indication |   |   |   |
| Information Obtained | Absorption, mixing time, mixing tolerance (general strength) | $\frac{R}{E} = \frac{\text{Resistance}}{\text{Extensibility}} = \frac{\text{Degree of}}{\text{Maturing}}$ (Indicating fermentation and machining behavior) | Crumb formation characteristics (Controlling crumb softness and rate of staling) |
| Correction Possibilities in a flour mill: | Changes in wheat blend | Adjustment in "bleach" (chemical maturing agents) | Mill stream switching and/or malt additions (diastasing) |
| in a bakery: | Absorption and mixing changes | Adjustment of yeast food | Malt additions |

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# STUDIES ON AMINO ACID SUPPLEMENTATION OF CEREALS[1]

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THE ADDITION OF amino acids or concentrates of amino acids to cereals and cereal proteins has been studied for many years and by many different workers. In this short paper no attempt will be made to survey the literature or summarize the extensive investigations that have been carried out. Rather, data will be presented which have been obtained recently with rats fed three different cereals — rice, corn, and wheat, supplemented with different combinations of amino acids, in which both growth data and changes in liver fat have been observed. Also, an attempt will be made to explain possible imbalances which may be produced when individual amino acids are added to cereal proteins. It is obvious that with eight or more essential amino acids, and possibly several nonessential amino acids, which may affect metabolism, a tremendous number of combinations is possible. However, in spite of these difficulties there seems to be some pattern developing as far as amino acid imbalance is concerned.

Our earlier studies involving amino acid imbalance, such as the relationship between threonine and tryptophan, leucine and isoleucine, were conducted with a synthetic ration containing 9% casein as a sole source of protein. It appeared to us that similar studies should be conducted with the cereals, since the protein level of diets in which the protein is supplied by cereals will vary from 5 to 10%. It is practically impossible to raise the protein level of any diet above 10% when cereals supply the sole source of protein.

### Studies with Rice

The first cereal studied was polished rice, and two papers have been published on this subject from our laboratory (2, 3). All the diets used in these studies contained 5% of corn oil, 4% of salts, and a mixture of the B-vitamins, in addition to the cereal to be studied. A small amount of sucrose was used to make the ration up to 100%, and the amino acid supplements were added at the expense of sucrose. Halibut liver oil, fortified with vitamins E and K, was given orally each week. These results may be summarized very briefly. In confirmation of the observation of Pecora and Hundley (4), growth was improved when both lysine and threonine were added to the rice diet, and further improvement was obtained only when a mixture of all of the remaining essential amino acids was included. When the rice diet was unsupplemented, the growth rate per week was 8 to 10 g. and the liver fat was 32% on a dry-weight basis. The normal liver fat is about 10% on dry-weight basis. The inclusion of 0.2% L-lysine hydrochloride and 0.24% of DL-threonine produced significant growth response, but had no effect on accumulation of liver fat. However, the fat content of liver was normal when 0.4% L-lysine hydrochloride was included with either 0.24% or 0.5% of DL-threonine. The higher level of lysine produced some retardation in growth which was overcome by increasing the levels of leucine, isoleucine, valine, and histidine. When the animals were retained on the diet for longer periods of time, the growth-retarding effect of the additional lysine disappeared without addition of the other amino acids to the diet. However, if lysine was not added, the accumulation of liver fat persisted for many weeks.

TABLE I

GROWTH AND LIVER FAT IN RATS FED A RICE DIET SUPPLEMENTED WITH AMINO ACIDS

| | | Amino Acids Supplied in Ration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Group[a] | | Protein | Lysine | Threonine | Histidine | Tryptophan | Cystine + Methionine | Growth | Liver Fat |
| | | % | % | % | % | % | % | g/wk | % dry weight |
| 1 | Rice 87% | 5.4 | 0.2 | 0.20 | 0.09 | 0.056 | 0.19 | 8.5 | 33.9 |
| 2 | Rice plus amino acids | 5.4 | 0.4 | 0.32 | 0.09 | 0.056 | 0.19 | 22.0 | 25.0 |
| 3 | Rice plus amino acids | 5.4 | 0.6 | 0.45 | 0.09 | 0.056 | 0.19 | 16.0 | 10.6 |
| 4 | Rice plus amino acids | 5.4 | 0.6 | 0.45 | 0.23 | 0.056 | 0.19 | 27.2 | 13.8 |

[a] Supplement group 2 — 0.2% L-lysine, 0.12% threonine; group 3 — 0.4% L-lysine, 0.25% threonine; group 4 — 0.4% L-lysine, 0.25% threonine, 0.16% histidine.

The addition of 3 or 6% of a number of different animal proteins to the rice diet supported an excellent rate of growth and maintained liver fat at normal levels. It is apparent from these studies that lysine is intimately connected with both growth and prevention of liver fat and that the level for stimulation of growth may be different from that needed for prevention of liver fat. In Table I are shown actual levels of certain of the amino acids supplied by the rice diet, and also the levels supplied when supplements of the amino acids were made. Growth data and the liver fat data are also included. It is apparent from the figures given in this table that 87% of rice supplies levels of lysine, threonine, histidine, and tryptophan considerably below the accepted requirements for the rat; for example: 0.2% lysine is supplied and the lysine requirement is accepted at 1%; threonine is supplied at a level of 0.2% and the accepted requirement is 0.5%. Nevertheless the addition of 0.2% lysine and 0.12% threonine gives a very significant growth response, although the total level of lysine supplied is still less than one-half the accepted requirement. However, this supple-

[1] Manuscript received July 16, 1956. Published with the approval of the Director of the Wisconsin Agricultural Experiment Station. Presented at the 41st Annual Meeting, New York, May 1956.

mentation does not decrease the liver fat to a normal level. When the lysine is increased to 0.6%, which is still below the accepted requirement, the liver fat is normal but there is some retardation of growth. This retardation in growth is overcome by the addition of 0.16% histidine, although this supplement increases the liver fat slightly. Again, the total level of histidine, 0.23%, is below the accepted requirement of 0.4%. Earlier work with casein indicated that threonine was especially significant in the prevention of fatty livers. However, in the work with rice, it appears that lysine may also be an important amino acid for the prevention of liver fat. Some indication of the effectiveness of lysine was obtained in earlier studies in which egg albumin was the sole source of protein. In this case the addition of lysine and histidine reduced the level of liver fat, but lysine did not appear to be active unless other amino acids also were present.

## Need of Isoleucine in Corn Diets

Since most cereals are limiting in lysine it appeared even more important to extend our studies to corn and wheat. When a diet containing 90% of corn and the other essential constituents was used, quite different results were obtained. Although the corn supplied 8.3% of protein, which is considerably higher than that supplied in a rice diet, the growth was much less — 2.2 g. per week — but the liver fat remained normal, about 12% on a dry-weight basis. Numerous attempts have been made to supplement corn or corn proteins with amino acids at levels to supply the requirements of the rat. In spite of these supplements, the growth of rats fed corn diets has always been suboptimal. We have now found that this is due to the limited availability of isoleucine and the fact that a high level of leucine increases the requirement of isoleucine. By supplying isoleucine at a level which increases the intake to three times normal requirement, together with supplements of the other amino acids which are supplied below the minimum requirements, it is possible to obtain growth which one may consider quite normal (1). Thus in any studies involving corn or corn proteins it is necessary to supplement the ration with extra amounts of isoleucine.

TABLE II

EFFECT OF AMINO ACID SUPPLEMENTS ON GROWTH AND LIVER FAT IN RATS FED CORN DIETS

| | | | ADDED AMINO ACIDS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| GROUP | CORN | PROTEIN | L-Lysine | DL-Threonine | DL-Tryptophan | DL-Valine | DL-Isoleucine | RATE OF GAIN | LIVER FAT |
| | % | % | % | % | % | % | % | g/wk | % dry weight |
| 1 | 89[a] | 8.3 | ... | ... | ... | ... | ... | 2.2 | 12.4 |
| 2 | 89 | 8.3 | 0.4 | 0.2 | 0.1 | 0.2 | 0.6 | 24.8 | 15.0 |
| 3 | 89 | 8.3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.6 | 12.7 | 18.5 |
| 4 | 89 | 8.3 | 0.1 | 0.1 | 0.1 | 0.2 | 0.6 | 17.8 | 20.9 |
| 5 | 58[b] | 5.4 | 0.15 | 0.2 | 0.1 | 0.2 | 0.6 | 10.2 | 30.1 |
| 6 | 58 | 5.4 | 0.45 | 0.2 | 0.1 | 0.2 | 0.6 | 21.0 | 17.6 |

[a] 89% Corn supplied 0.23% L-lysine and 0.33% L-threonine.
[b] 58% Corn supplied 0.15% L-lysine and 0.21% L-threonine.

Table II summarizes some of the effects obtained by supplementing the corn diet with amino acids. Without any supplement, 89% of corn supplied 0.23% of lysine, which is slightly higher than that supplied by 87% rice, but supplied 0.33% of threonine which is considerably higher than that supplied by the rice. On this diet growth is very poor but liver fat is in the normal range. Addition of 0.4% lysine and 0.2% threonine together with tryptophan, valine, and isoleucine produced a significant growth response and a slight increase in liver fat. When the lysine supplement is reduced to 0.1%, growth response was correspondingly smaller and liver fat was still higher. When the threonine supplement was reduced from 0.2 to 0.1% and fed together with 0.1% lysine, growth was slightly better, but again liver fat showed an increase. This indicates the very delicate balance which we must recognize when amino acid supplementations are made to cereal proteins.

TABLE III

GROWTH AND LIVER FAT IN RATS FED CORN DIET SUPPLEMENTED WITH AMINO ACIDS[a]

| | | | AMINO ACIDS SUPPLIED IN RATION | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| GROUP | | PROTEIN | Lysine | Threonine | Histidine | Tryptophan | Cystine + Methionine | GROWTH | LIVER FAT |
| | | % | % | % | % | % | % | g/wk | % dry weight |
| 1 | Corn 89% | 8.3 | 0.23 | 0.32 | 0.17 | 0.05 | 0.26 | 2.2 | 12.4 |
| 2 | Corn 89% plus amino acids | 8.3 | 0.63 | 0.42 | 0.17 | 0.10 | 0.26 | 24.8 | 15.0 |
| 3 | Corn 58% plus amino acids | 5.4 | 0.30 | 0.31 | 0.11 | 0.08 | 0.17 | 10.2 | 30.1 |
| 4 | Corn 58% plus amino acids | 5.4 | 0.60 | 0.31 | 0.11 | 0.08 | 0.17 | 21.0 | 17.6 |

[a] Diets for all groups were supplemented with 0.2% DL-valine and 0.6% DL-isoleucine.

## Liver Fat with Rice and Corn Diets

In an attempt to explain the difference in accumulation of fat on rice diets and corn diets, we reduced the level of corn in the diet sufficiently to give a protein intake equivalent to that of the rice diets; 58% corn was used, and in this case the lysine supplement was 0.15% together with the other supplements shown in group 5. With this diet the growth was 10 g. per week and the liver fat was very high, 30%, and very similar to that obtained on the rice diets. The further addition of 0.3% lysine reduced the liver fat significantly and produced a large increase in growth. In Table III are given the actual levels of the different amino acids in the corn alone and when the various supplements were added. If we compare group 3 in Table III with group 2 in Table I, it is apparent that comparable levels of liver fat are obtained. The group receiving rice had a slightly lower level of liver fat but in this case the lysine intake was 0.4% rather than 0.3%. If a group had been included receiving 0.3% lysine on the rice diet, undoubtedly the levels of liver fat would have been identical. It is also important to emphasize that the corn diets were supplemented with additional amino acids in order to obtain fairly good growth; otherwise the results with rice and corn could not be compared. If we compare these results with our earlier data on casein, it is interesting that 9% of casein supplied 0.6% lysine but only 0.34% threonine. This probably explains why threonine is more effective in preventing fatty livers when

casein diets are used than is lysine.

### Liver Fat with Whole Wheat Diet

When whole wheat was used as the cereal, the level of protein supplied was higher than that with corn, and, as one might expect, the growth was slightly better than that obtained with rice, but again the liver fat was normal. Most of our studies with wheat have been with patent flour rather than with whole wheat. As is shown in Table IV, 78% of wheat flour supplied 9.6% protein but allowed

TABLE IV

EFFECTS OF AMINO ACID SUPPLEMENTS ON GROWTH AND LIVER FAT IN RATS FED ENRICHED WHEAT FLOUR

| Wheat Flour | Protein Supplied by Wheat | Supplements | Growth | Liver Fat |
|---|---|---|---|---|
| % | % | | g/wk | % dry weight |
| 78[a] | 9.6 | .... | 3.2 | 13.9 |
| 78 | 9.6 | 0.5% L-lysine + 0.4% DL-threonine | 21.3 | 13.2 |
| 78 | 9.6 | 0.9% L-lysine + 0.6% DL-threonine | 20.0 | 11.1 |
| 78 | 9.6 | 8 essential amino acids[c] | 28.0 | 7.8 |
| 78 | 9.6 | 6% Fibrin + 0.4% L-lysine + 0.4% DL-methionine | 36.0 | 10.3 |
| 44[b] | 5.4 | 0.6% DL-threonine | — 0.8 | 33.4 |
| 44 | 5.4 | 0.6% DL-threonine + 0.9% L-lysine | 4.6 | 13.0 |

[a] 78% Wheat flour supplies 0.19% L-lysine and 0.26% L-threonine.

[b] 44% Wheat flour supplies 0.11% L-lysine and 0.15% L-threonine.

[c] The following amino acids were supplied: L-lysine, 0.9%; DL-threonine, 0.6%; DL-tryptophan, 0.3%; DL-methionine, 0.6%; L-histidine, 0.2%; DL-phenylalanine, 0.4%; L-leucine, 0.2%; DL-isoleucine, 0.2% and DL-valine, 0.6%.

a growth of only 3.2 g. per week. The level of liver fat was in the normal range. Supplements of 0.5% L-lysine and 0.4% DL-threonine increased the growth to over 20 g. per week with no effect on liver fat. The higher levels of lysine and threonine had no further effect on growth or liver fat. When eight essential amino acids were added, growth was somewhat better than that obtained with supplements of only lysine and threonine, although the growth was not as good as that obtained when 6% of fibrin was added together with 0.4% lysine and 0.4% DL-methionine. When the wheat flour was reduced to 44%, which supplied 5.4% of protein, the same amount as supplied by rice, and supplemented at 0.6% DL-threonine, growth was very poor but liver fat now was elevated to 33%. The addition of 0.9% lysine to this diet increased growth only slightly but returned liver fat to a normal range. The actual levels of the various amino acids in the wheat flour diet and in the diet supplemented with amino acids are given in Table V. It is interesting to point out that 78% wheat flour supplies almost exactly the same level of lysine and threonine as does 87% rice, yet growth is slightly less and liver fat is in a normal range.

### Balance between Amino Acids Very Delicate

This clearly indicates that we cannot compare the levels of lysine and threonine without giving consideration to the level of other amino acids in the diet. However, when the level of lysine is reduced to 0.11% with the wheat diet, liver fat is increased to 33%. Many additional

TABLE V

GROWTH AND LIVER FAT IN RATS FED WHEAT FLOUR SUPPLEMENTED WITH AMINO ACIDS

| Group | | Amino Acids Supplied in Ration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Protein | Lysine | Threonine | Histidine | Tryptophan | Cystine + Methionine | Growth | Liver Fat |
| | | % | % | % | % | % | % | g/wk | % dry weight |
| 1 | Wheat flour, 78% | 9.6 | 0.19 | 0.26 | 0.18 | 0.10 | 0.29 | 3.2 | 13.9 |
| 2 | Wheat flour, 78% plus amino acids | 9.6 | 1.09 | 0.56 | 0.18 | 0.10 | 0.29 | 20.0 | 11.1 |
| 3 | Wheat flour, 44% plus amino acids | 5.4 | 0.11 | 0.44 | 0.10 | 0.05 | 0.17 | —0.8 | 33.4 |
| 4 | Wheat flour, 44% plus amino acids | 5.4 | 1.01 | 0.44 | 0.10 | 0.05 | 0.17 | 4.6 | 13.0 |

intermediate levels of several amino acids must be fed to establish all relationships clearly. These preliminary data emphasize that levels of amino acids which may tend to produce optimum growth may not allow normal metabolic functions. These metabolic disturbances may lead to the accumulation of liver fat, and perhaps other changes if we were able to measure them. These deficiencies are readily overcome by addition of proteins of high quality. When cereal proteins are not supplemented with good-quality proteins, one may expect to see some of the symptoms which may be related to amino acid imbalance. Furthermore, the addition of individual amino acids may aggravate this imbalance rather than prevent it. It appears possible to supplement at least the three cereal proteins which we have studied with combinations of amino acids which will give optimum response. The limited data obtained so far do not allow us to give the exact figures for each individual amino acid; further studies should make this possible. In any case, it is perfectly clear that the balance between certain amino acids is very delicate and that no attempt should be made to supplement cereal proteins indiscriminately with amino acids until we understand these relationships and until we know the level of the individual amino acids supplied by the given proteins. These levels must be considered not only from the point of view of total amount present but on the basis of availability of certain amino acids.

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# THE PHILOSOPHY OF AMINO ACID FORTIFICATION OF FOODS[1]

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THE FIRST HALF of this century will be remembered as that remarkable period when practically all of the essential nutrients were discovered, isolated, identified, and finally synthesized. At the same time, corresponding advances were being made in the technology of chemical manufacture, so that when the need for certain critical vitamins and mineral salts became clear, they could be made available in large quantities at reasonable prices. By the late 1930's the synthesis of thiamine and the other B-vitamins had rendered possible the enrichment of cereal foods with these nutrients. A survey of intakes of these nutrients and of the nutritional status of the American population indicated the desirability of adding them to flour and other cereal foods. Under the prompting of leading nutrition authorities a nationwide program was begun in 1941 (46).

The addition of these nutrients to cereal products was based upon rather clear-cut concepts of the need for definite minimum requirements and of the relationship of deficiencies to well-defined pathological manifestations. Statements of policy on food enrichment issued by the Food and Drug Administration, the National Research Council, and the American Medical Association affirm in essence the desirability of ensuring adequate nutrient intakes to overcome visible or suspected deficiency states in the population. In addition, the philosophy has been expressed that the enrichment should benefit significant population groups, if not the entire population, and that the foods chosen for enrichment should be effective vehicles for carrying the nutrients to those people who show signs of inadequate intakes (4, 46, 47).

In recent years there has been great progress in the understanding of the metabolic role of protein and amino acids. Certain of the amino acids are known to be in short supply in many staple foods, particularly those of cereal origin. Advances in chemical technology now give promise of making these critical amino acids available in quantity at reasonable prices. It has therefore become possible to consider the question of amino acid fortification in a practical way, and attempts have been made to evaluate this possibility in terms of the philosophy that was developed for vitamin and mineral enrichment. That is, questions are asked about minimum requirements, about specific deficiency syndromes that can be attributed to amino acid shortages, and about which population groups may benefit by receiving more of a particular amino acid.

### What Are Individual Requirements?

Certain fundamental difficulties at once appear in the attempt to apply this philosophy to amino acid fortification. First and foremost of these difficulties is the extremely scanty knowledge we have of the requirements for individual amino acids, particularly during the periods of nutritional stress in the life span when we are most concerned that optimum protein nutrition should be supplied. Most of the data we have are on the minimum requirements for nitrogen balance in healthy young men. The thorough, painstaking studies of W. C. Rose (53) with this group have been followed by similar experiments with men and women by Leverton (33), Reynolds (30), Mertz (15), and their co-workers. Remarkably low values have been found for individual amino acid requirements under the conditions and criteria employed. As a result, one may be tempted to dismiss the question of protein malnutrition as a problem of little practical importance. However, consideration of the rapid turnover rates and short half-lives of many body proteins (8) and the fact that amino acids from these stores could temporarily make up for dietary deficiencies soon leads us to caution in this regard.

### The Adult Organism a Buffer System

In examining the data of these investigators, one is impressed with the fact that the adult organism, when its intake of a particular amino acid is reduced, responds in a manner characteristic of what one would call a highly buffered system. For example, it is uniformly observed that the minimum requirements for adults have no apparent relation to body size. Furthermore, large reductions may be made in the intake of an amino acid, each time with loss of nitrogen and re-establishment of a new equilibrium point. Taking lysine as a specific example, one notes that even when the average normal daily intake of adults in this country is reduced by about 90%, nitrogen equilibrium can still be maintained, at least for the periods of experimental observation employed so far. Usually it is only when the lysine intake falls below 400–800 mg. per day that the protein economy of the body disintegrates.

In simple terms, what do we mean by a buffered system? We mean that there is a reservoir in the system that takes up or liberates a reactant, depending on whether there is an abundant or scanty supply of the material. This reservoir becomes larger when the reactant is in good supply and smaller when there is less of the reactant available.

### Amino Acid Resources of the Body

There are several pieces of evidence indicating that such reservoirs or labile protein stores are important in temporarily sparing the body's requirements for amino acids. Mertz and co-workers found that their subjects

[1] Manuscript received August 6, 1956. Presented at the 41st annual meeting, New York, May 1956.

could be maintained in nitrogen balance on 500–700 mg. of lysine daily. However, one subject who was initially in balance on a 600-mg. intake could not be brought into equilibrium with 700 mg. after 20 days on a lysine-deficient diet. Another subject treated similarly for 20 days was in negative equilibrium with 900 mg. of lysine (15). These observations are suggestive of depletion of a labile store capable of providing some of the body's needs for lysine over the usual short experimental periods. Several highly significant studies by Nasset also require mention. In studying the adult rat's requirement for histidine he found that nitrogen equilibrium could be maintained for long periods on rather low intakes. However, this was accompanied by progressive lowering of hemoglobin levels, and it appears that much of the histidine requirement for equilibrium was met by catabolism of this protein (43).

### "Between-Meals" Resynthesis Needed

Even more illuminating on the point of the body's resources of amino acids are Nasset's observations on the amounts of enzymes and other digestive proteins that are poured into the intestinal tract during digestion of foods (19, 42, 44). Here is a source of protein and amino acids that is expended and resynthesized at high rates. From the amounts of nitrogen observed by Nasset in the course of one digestion, it is apparent that these labile stores must in large part be resynthesized from one meal to the next, with part of the necessary amino acids coming from hydrolysis of the food protein and part from decomposition of the enzymes themselves. Complete exhaustion of these stores in infants has been demonstrated by Scrimshaw in discussing the devastating effects of severe protein deficiency on the organs that secrete digestive enzymes, such as the liver, pancreas, and intestinal walls (55).

Even the infant appears to have resources for temporarily meeting a portion of his amino acid needs when subjected to deprivation for short periods, as shown recently by Holt. He found that positive nitrogen retention persisted for a few days even when no lysine whatever was supplied in the infant's diet (25).

### Safe or Recommended Allowances

If the data on minimum requirements for amino acids may involve undetermined contributions from the body's protein stores, what then are safe or recommended allowances? Rose adopts the procedure of doubling the minimum requirement. Granting that this may be satisfactory for the adult, what is one to conclude about safe allowances for infants, pregnant women, and other groups under nutritional stress? One can safely predict that it will be many years before sufficient data are available to permit firm conclusions.

### Deficiency Syndromes

We turn now to the question of specific deficiency syndromes for individual amino acids. If these exist, one can determine how much of an amino acid is needed to restore normal conditions, and this will help to define a requirement. This is a procedure that works well with vitamins, because the vitamins are involved in specific enzyme systems. Failure of these to function properly results in obvious lesions or pathology. The same does not hold true for amino acids. A few poorly defined deficiency syndromes have been reported when particular amino acids were completely absent from the diet (25). However, under real-life conditions where amino acid deficiency is not total but partial, we do not find such syndromes in normal individuals. Partial amino acid deficiency, that is, departure from the amino acid balance found in high-quality proteins, leads only to the same physical results as restriction of total protein intake (22). That is, synthesis of tissue proteins and enzymes is retarded throughout the body.

### Farm-Animal Nutrition — An Approach

It is clear that if any practical approach is to be made to amino acid fortification of human foods at the present time, it cannot be based on quite the same concepts that were effective in establishing a basis for vitamin and mineral enrichment. Fortunately, there is a field of nutrition where we can look for additional concepts that may be of help in formulating a near-term approach. This field is farm-animal nutrition. The manufacture of livestock and poultry feeds involves amino acid supplementation in a very practical way. The blending of various feed ingredients is largely an attempt to achieve a desirable amino acid balance. Interest in amino acid supplementation is high. For the past several years, hardly a month has gone by without the appearance of one or more papers in technical journals and feed trade publications on experimentation with lysine, methionine, and other amino acids in animal feeds. Substantial tonnages of methionine are now being put into commercial poultry feeds.

In animal husbandry, there is only one justification for amino acid supplementation, and that is to improve efficiency of protein utilization, or the pounds of lean meat produced per pound of protein fed.

### Improving Protein Efficiency

The concept of seeking improvement in protein efficiency is important for human as well as farm animal nutrition. Improvement in protein efficiency or biological value has two aspects. First, it implies that a greater *quantity* of tissue protein can be synthesized from a given amount of food protein. This is a consideration of importance to the physician and public health worker when dealing with inadequate protein intakes, whatever the cause — poor appetite, faulty dietary habits, or low income. Secondly, it means that tissue protein can be synthesized at a higher *rate* at a given intake of protein. Both aspects are illustrated in Fig. 1, showing gains in nitrogen or total body protein by weanling mice over a 20-day period on different food proteins (based on the

data of Bosshardt and co-workers (9)). The rate factor is of special interest to physicians and nutritionists in planning diets adequate for convalescence and for the states of high anabolic demand exemplified by infancy, early childhood, adolescence, and pregnancy.

The high-quality animal proteins give highest protein efficiency not only for young mice, as shown in Fig. 1, but for the young of all mammals, including man. These proteins are all quite similar in amino acid pattern. What about the amino acid pattern required for highest protein efficiency in adult humans? The studies of Murlin, Nasset, and co-workers have demonstrated the high biological value of animal proteins in adult nutrition (23, 41, 45). Additional information is available from a study by Bricker, Mitchell, and Kinsman on adult young women consuming different types of diets (10). Table I shows grams of protein per day required for maintenance of a 65-kg. subject on the various diets, as calculated from the data of these workers.

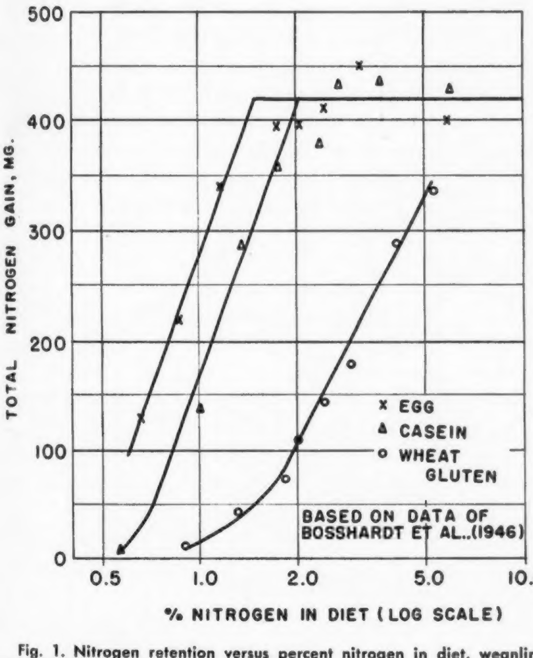


Fig. 1. Nitrogen retention versus percent nitrogen in diet, weanling mice, 20-day feeding period. (Reference 9.)

TABLE I

PROTEIN MAINTENANCE REQUIREMENT FOR HEALTHY YOUNG WOMEN[a]

| SOURCE OF PROTEIN | PROTEIN (N × 6.25) REQUIRED PER DAY FOR 65-KG. SUBJECT |
|---|---|
| | g. |
| Milk | 40.0 |
| White flour | 69.0 |
| Soy flour | 43.3 |
| Soy-white flour[b] | 50.4 |
| Mixed foods[c] | 46.0 |

[a] From data of Bricker *et al.* (ref. 10).
[b] 13% Soy flour in mixture, contributing 36% of nitrogen.
[c] Included egg, milk, ground beef, soy-wheat biscuit, vegetables, fruit (about 55% animal protein).

Note that best protein efficiency was observed with protein of 100% animal origin. The mixed diet, containing about 55% animal protein, as well as some soy protein, with the rest of the protein coming mostly from wheat, was less efficient. This is contrary to the results usually obtained in rat growth studies, where mixtures of equal parts animal and cereal protein are frequently equal to or better than animal protein alone. These results with rats form the basis for the frequently made generalization that animal and cereal proteins supplement each other's amino acid patterns, a conclusion that does not necessarily apply to humans.

Mitchell has ascribed differences between the human and the rat in amino acid needs to differences in relative surface area and requirements for synthesis of keratins (38). The hairy coat and relatively high skin area per kg. of body weight in small animals like the mouse and rat weights the pattern of amino acid requirements in the direction of keratin composition — that is, toward a higher ratio of sulfur-amino acids and a lower ratio of lysine. Such a pattern is available from a 50:50 mixture of animal and cereal protein. An illustration of the difference between the human and the rat is given by growth studies on diets whose protein comes from milk. When the protein intake is reduced to a level restricting growth, the limiting amino acid for infants is found to be lysine (3), whereas for the young rat it is methionine or cystine (50). Cox and co-workers obtained no response in infants to supplementation of a casein digest with methionine, a result differing from that in the rat or dog (17). Murlin found that egg and soy protein, fed at endogenous levels to adult men, could be somewhat improved in biological value by supplementation with lysine but not methionine (40). Mitchell has reviewed evidence indicating that this difference in lysine and sulfur-amino acid requirements between humans and laboratory animals persists in adulthood (38). Available knowledge, therefore, indicates that the protein efficiency of human foods can be brought to a maximum by adjusting the amino acid pattern to resemble that of 100% animal protein rather than that of a mixture of animal and cereal protein.

There is an obvious need for increased protein efficiency in many foreign areas, where protein supplies are low and of poor quality (21). However, many of those at this meeting are more immediately concerned with nutrition in the United States. Are there any groups in this country for whom it would appear desirable to improve protein efficiency? What we must look for is evidence that significant numbers of individuals show retarded rates of tissue synthesis by comparison with individuals considered to be in a good nutritional state. Such evidence is readily found in the medical and nutrition literature.

### Protein Malnutrition

Jeans has reported that the majority of American children under the age of 6, because of inadequate protein intakes, are undermuscled by comparison with well-nourished children of the same age. Normal muscle mass can be developed by supplying recommended protein allow-

ances (26). Other studies have shown that large numbers of older children, up through the years of adolescence, are receiving less high-quality protein than the amounts generally considered desirable (5, 16, 20, 28, 52, 68). In recent years much has been learned about severe protein malnutrition in children as it occurs in underdeveloped areas (7, 11, 12, 55, 67). A milder protein deficiency syndrome, as observed in American children, has been reported on by Lynch and Snively (37). They believe this to be "one of the most prevalent clinically manifested deficiency diseases which affect children." They note that "the child's diet is nearly always adequate in minerals and vitamins but is not adequate in protein." Presenting complaints include failure to grow normally, poor muscle development, listlessness, peevishness, poor appetite, gastrointestinal upsets, repeated bouts of infectious disease, increased incidence of caries, and pallor. This list shows a striking similarity, though in milder degree, to the signs and symptoms of severe protein deficiency as reported by Autret, Behar, Brock, Scrimshaw, Waterlow, and others (7, 11, 12, 55, 67). Undoubtedly the studies now in progress throughout the world will soon provide us with a much clearer understanding of the protein deficiency syndrome as it occurs in children on diets of different levels of adequacy.

In pregnancy, a protein intake of about 85 g. a day, chiefly of high quality, is considered desirable for good health of both mother and infant (36). Surveys have shown that only 10 to 20% of expectant mothers consume the recommended amount (69). At lower protein intake, a particular individual may experience no important ill effects. Nevertheless, statistics show that an increasingly higher percentage of pregnant women are troubled with toxemias, edema, reduced hemoglobin, lowered plasma protein, and other complications as the content of good-quality protein in their diets is reduced, despite use of vitamin and mineral supplements (6, 13, 14, 34, 56, 59).

In old age many individuals are found to be losing body nitrogen continually, and reduced intake of high quality proteins is believed to play a part in this phenomenon (18, 31, 32, 39, 48, 57, 65). Low income, poor dentures, impaired digestion, and reduced kidney capacity may all be factors in reducing intake of good protein. Whatever the cause, this phenomenon may lead to habitual fatigue, anemia, and loss of muscle strength (57). Reversal of this gradual depletion is possible with increased consumption of protein (32), and it seems desirable in all cases that the protein should be of highest biological value (1, 66).

Retarded synthesis of body tissues may result not only from low protein intakes or poor amino acid balance, but from deficiency of vitamins, minerals, or other critical nutrients. However, in this country the enrichment of cereals with B-vitamins, milk solids, and iron, of milk with vitamin D, and of margarine with vitamin A makes it unlikely that deficiencies of this nature play any important role in the observed frequency of substandard nitrogen retention. It appears that the real need in these cases is to increase the quantity and efficiency of the protein supplied.

### Cereals Best Vehicles for Protein Nutrition

We come now to the question of what foods may be suitable vehicles for carrying improved protein nutrition to these population segments. A significant fact emerges from the numerous surveys carried out by the government and others on American diets (27, 51, 60, 61, 62, 63, 64). This is that, when intake of animal protein foods falls below generally recommended levels, the percentage of total protein derived from cereal foods typically becomes larger. Normally, cereal protein accounts for about one-fifth of total protein, but it may contribute 40% or more of the total in poorer diets. An example of this is shown in Fig. 2, taken from a study by Jeans and coworkers (27). Cereal foods, therefore, are inevitably the vehicles of choice to carry more and better protein to the American people.

An available means of prime importance for improving the protein value of cereal foods is to incorporate in them such protein sources as nonfat milk solids, lactalbumin, and casein, which are of inherently high efficiency. These should be incorporated to the maximum extent that is compatible with commercial considerations such as taste, color, texture, and physical form.

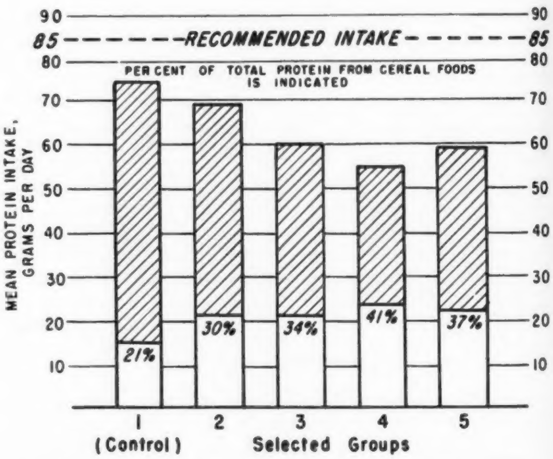


Fig. 2. Contribution of cereal protein in diets of a population group having a high protein need. Selected groups: 1, control group — wives of college students; 2, wives of farm laborers; 3, wives of town laborers; 4, wives of unemployed laborers; 5, unmarried women. (Jeans et al., reference 27.)

### Increasing Cereal Protein Efficiency

A second and supplementary means of improving the protein value is now becoming feasible. This is to add such amino acids as are needed to balance the deficiencies of cereal protein. Theoretically all common cereal proteins can be improved in this way (21). In practice, we must for the present limit our consideration to wheat protein, on which there is a long history of experimentation dating

back to the time of Osborne and Mendel. The problems of fortifying other cereals, such as rice and corn, are not yet as clearly understood. In the United States, of course, the dominant cereal in human diets is wheat.

Osborne and Mendel demonstrated over 40 years ago that addition of lysine to wheat protein markedly increased its efficiency or biological value (49). A great many similar studies have been carried out since then, of which only a few will be mentioned. Figure 3, which compares the amino acid pattern of wheat with the high quality pattern of egg protein, defines the problem.

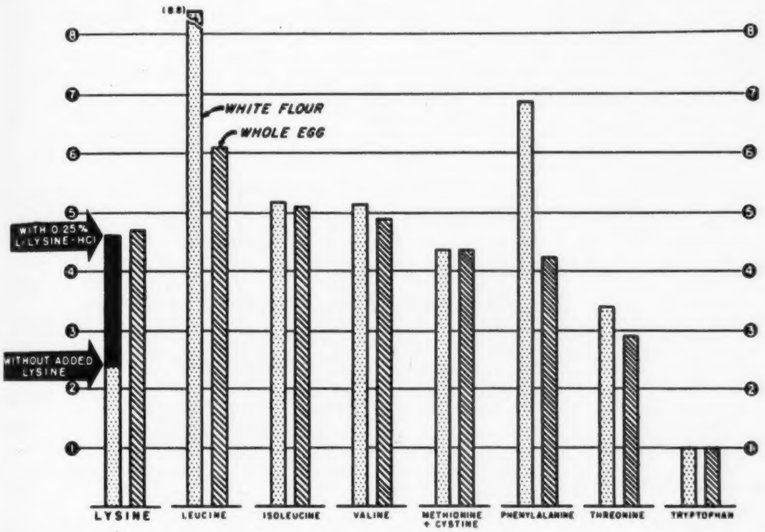


**Fig. 3. Amino acid proportions in egg and white flour protein. Proportions by weight, based on tryptophan as unity.**

Relative to the other essential amino acids, wheat protein contains only half as much lysine as it should for high protein efficiency. At low levels of protein intake and in the absence of milk, other amino acids may also be necessary for maximum efficiency, at least in the rat. For example, Light and Frey (35) and Sure (58) found, in work with weanling rats, that additional improvements in the value of white flour protein over that accomplished by lysine supplementation could be gained by adding valine and threonine. However, Rosenberg and co-workers found that young rats exhibit no growth response to threonine, valine, or methionine beyond that given by lysine alone, provided 3% or more of milk solids, based on weight of wheat flour, is present (54). It would appear, then, that lack of commercial availability of threonine and valine imposes no practical obstacle to the accomplishment of a substantial improvement in the protein value of wheat foods. Furthermore, since our concern is with the nourishment of humans rather than rats, it is of interest to point out that addition of lysine alone to wheat gluten, the protein of white flour, has been demonstrated to raise its protein efficiency into the animal protein range for both infants and adults (2, 3, 24).

In the American diet, most of the protein comes from animal foods, which by nature have a desirable amino acid balance, and from wheat. Addition of sufficient lysine to bring about an animal protein-type balance in wheat foods would be a move to improve the amino acid balance and protein efficiency of the diet as a whole.

Using lysine together with milk proteins, therefore, the cereal foods industry will have, when larger quantities of lysine are available, a potent means of bringing greater quantities of high-efficiency protein into our diets. As previously mentioned, because of the nature of American diets, the nutritional impact of this should be greatest precisely where it is most needed, that is, where intake of animal protein foods and total protein is poorest.

### Dietary Habits and Cereal Foods

There are three additional aspects of our dietary habits that offer both a challenge and an opportunity to the cereal foods industry. First is our national habit of eating light meals and snacks based mainly on cereal foods. Examples are the tea and toast breakfast, the "coffee break" with doughnuts or pastry, the jelly sandwich "break" of the school child, the munching of sugar-coated cereals or cookies by children, and so on. It is nutritionally desirable to have high-quality protein at each meal, and the cereal food industry can potentially meet this need with products of high-quality protein value.

A second aspect of our diets that is pertinent to this problem is the trend toward lower caloric intakes. This is a consequence of our machine civilization, which has made the majority of our population sedentary. It is also a consequence of the educational program of the medical profession against obesity. It is generally recognized that requirements of protein, vitamins, and minerals do not decline significantly, if at all, as caloric intake declines. Consequently, for good nutrition it is important that the smaller average food intake should be proportionately richer in essential nutrients. Here, too, cereal foods enhanced in protein value and enriched in vitamins and minerals would be in accord with dietary trends.

Finally, there is the matter of dietary faults that develop when incomes and standards of living are high. Luxury foods are more frequently consumed, and frequently these are merely sources of what Jolliffe has aptly termed "empty calories" (29). The greater the consumption of empty calories, the more important it is that the remainder of the diet be rich in the protective nutrients. Again, enhancement of the protein value of cereal foods would seem to be in accord with desirable nutritional objectives.

### Basic Purpose of Amino Acid Fortification

To summarize, it is believed that the basic purpose of

amino acid fortification should be to improve the protein efficiency of staple foods. There is a need for more high-efficiency protein, not only in many foreign areas but also in the United States, where inadequate or suboptimum protein nutrition is common among important population groups, such as children, adolescents, pregnant women, the chronically ill, and the aged. Because of the nature of American dietary habits, cereal foods are uniquely suited to the task of bringing more high-quality protein to the individuals who most need it. It appears desirable to add more milk protein and similar high-efficiency protein to cereal foods generally, and the cereal protein itself can be converted into high-quality protein by direct supplementation with pure amino acids as these become commercially available.

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**Cohen Report**

*(Continued from page 159)*

jected the views put forward by the Medical Research Council and the Scientific and Medical Advisers of the Ministries and accepted those of us who favored enrichment. Thus, while being obviously impressed by the Widdowson-McCance Report, they rejected that portion which implied that enrichment of white flour was not necessary. The Panel stated quite categorically that nutrition in certain cases would fall below the level necessary for good health if there were a return to 70 to 72% flour to which vitamin $B_1$, nicotinic acid, and iron had not been restored.

The final conclusion was as follows:

"Taking into account all the circumstances, and bearing in mind particularly the needs of the vulnerable groups in the population, the Panel concludes that the available evidence does not reveal any ascertainable difference between National flour as defined in the Flour Order, 1953, and flours of extraction rate less than National flour, to which vitamin $B_1$, nicotinic acid, and iron have been restored in the amounts specified in the Flour Order, 1953, which would significantly affect the health of the population in any foreseeable circumstances. They believe, however, that differences between low-extraction flour enriched as specified and low-extraction flour not so enriched are significant."

This finding has caused considerable consternation among advocates of long-extraction flour, which includes many members of the Medical Research Council, but the decision has been accepted by the Minister of Agriculture, Fisheries, and Food, who is now engaged in drawing up fresh Flour Orders to implement the advice. Indeed, after the end of September the bread subsidy ceases and, although presumably the public will have choice, it seems almost certain that we shall have seen more or less the end of National (long-extraction) flour. This view will be appreciated in North America, where flour enrichment has always been favored even though on rather different standards from ours. Riboflavin, for example, will not be used in flour and this, it is considered, will be provided by the present tendency to increased milk consumption. At long last, after discussions in many parts of the world, an impartial and authoritative investigation has come out clearly for enrichment as against long extraction.

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Editor's Note. Dr. Kent-Jones was born in London in 1891 and was educated at the Mercers School and at Kings College, London. From his early youth he was keenly interested in chemistry, and eventually took his Ph.D. degree in the area of cereal chemistry, the title of his thesis being "A study of heat upon wheat and flour, especially in relation to strength."

Of course, during these early days of cereal chemistry, the late 1920's, few men were specialists from the scientific point of view, and certainly Dr. Kent-Jones was one of the pioneers.

His business career as a private consultant with Dr. A. J. Amos started in the early 30's. During the war their laboratory was of invaluable assistance to the British milling industry in overcoming many of the difficulties with which it was faced; also to the Ministry of Food, and other government departments.

Dr. Kent-Jones has been a member of the A.A.C.C. for years.

## EMPLOYMENT NOTICES

### FOOD CHEMIST

**Excellent opportunities – in a financially stable yet growing manufacturing organization – are offered to graduate chemists with extensive research and development experience in the dairy, baking or cereal industries.**

**Located in metropolitan New York, our progressive company policy provides many employee benefits including life insurance and retirement plan.**

**Please forward detailed resume of experience, education and salary requirements. All replies confidential. Our employees have been informed of this ad. REPLY BOX 211, American Association of Cereal Chemists, University Farm, St. Paul 1, Minnesota.**

### JOB WANTED

**Swiss, 25 years old, seeks position in milling or grain company. M.A. and Ph.D. in commercial sciences (technical milling engineer). One year of industrial experience. Speaks English, German, French, and Spanish. REPLY TO: Fred Stoeri, Fondation Suisse, Bd. Jourdan, Paris 14e, France.**

# People, Products, Patter

## . . . People

**G. L. Bertram** has been appointed director, Council of the Cereals Department of the Central Institute for Nutrition Research T. N. O. at Wageningen, The Netherlands. He succeeds the late **H. M. R. Hintzer.**

**Harold J. Brownlee** has retired from Quaker Oats Co. after 29 years of service. He was managing director and chairman of Quaker's European operations with headquarters in London. He has spent the past year traveling in the United States and now lives in Vancouver, Washington.

**Walter L. Clark** joins the food technology department of Cyanamid's research division at Pearl River, N. Y. He was formerly assistant professor in the Department of Biochemistry and School of Nutrition at Cornell University.

**J. Ray Coulter** has been named manager of manufacturing for the Agricultural Chemicals Division of American Cyanamid.

> **Joseph Cryns,** long-time member of Midwest Section A.A.C.C., died on June 20. Mr. Cryns was last employed by the Quartermaster Food and Container Institute in the cereal and baking field.

**B. Marlo Dirks,** chairman of Northwest Section, has resigned to accept a position with Proctor and Gamble in Cincinnati, Ohio. **Robert A. Larsen** of Pillsbury Mills was elected Vice Chairman in place of **Paul E. Ramstad** who was elevated to the chairmanship.

**Norman Eisenstein** has been elected president of the Chicago Dairy Technology Society.

**Paul J. Flory,** Acting Chairman of the Department of Chemistry at Cornell University, has been named Executive Director of Research for the Mellon Institute of Industrial Research.

Dr. Flory is well known professionally and is author of 106 papers published in scientific journals and a 670 page book, "Principles of Polymer Chemistry." Also, 22 patents have been issued to him as inventor or co-inventor.

**Fred W. Hatch,** manager of Shell Chemical's Agricultural Chemicals Division, has been elected president of the National Agricultural Chemicals Association to succeed **W. W. Allen.** Mr. Hatch has served as vice president of the association for the past two years.

**Carroll A. Hochwalt,** vice president for research, development and engineering of Monsanto Chemical Company, has been named winner of the 1956 Midwest Award of the American Chemical Society's St. Louis Section.

Dr. Hochwalt, widely known as an industrial research administrator as well as for earlier work on ethyl gasoline, detergents, synthetic rubber, synthetic fibers and polymers for use as plastics, was cited by the award committee for "scientific achievement, for leadership in industrial research and for contributions to the dignity of the scientist as a citizen."

> **H. R. Kraybill** died on September 30. At the time of his death Dr. Kraybill was vice president and director of research and education of the American Meat Institute Foundation.

**Irving Lifson** has been employed in the New York Sales Department of Larvacide Products, Inc. He previously represented Science Products Co. of Chicago, Ill., in the New York area.

**Peter P. Noznick** of Beatrice Foods Co. has been promoted to director of research.

**Edward S. Olney** has left American Stores Co. to join Kraft Foods research labs at Glenview, Ill.

**Arthur Carl Peterson** has been employed by C. A. Swanson & Co., Omaha, as a biochemist.

**Donald H. Robertson** joins General Foods Corp., Hoboken, N. J., as junior technologist.

**James H. Sharp** has been appointed vice president of Merck & Co., Rahway, N. J. He was succeeded as president of the international division by **Antonie T. Knoppers.**

**Herbert F. Smith** is now supervising chemist at Schenley Distillers Inc.

**Shiang Ping Yang,** after receiving his Ph.D. from Iowa State College, joined the research laboratories of Mead Johnson and Co. as chemist.

**John D. Zigler** was appointed general manager of the Plant Food Division of International Minerals & Chemicals Corp.

## . . . Products

Wilkens-Anderson Co. has just published a new Semi-Micro Catalog illustrating all types of special semi-micro glassware and equipment items adaptable to micro and semi-micro techniques. For a free copy write Wilkens-Anderson Co., 4525 W. Division, Chicago 51, Ill.

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The Rohm & Haas Company has developed a complete series of ion exchange resins specifically for chromatographic analyses. The new series is available in four resin classifications, each classification in two particle sizes.

Further information may be obtained by writing Rohm & Haas Co., Resinous Products Division, Washington Square, Philadelphia 5, Pa.

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Standard Brands Incorporated announces a new lemon pie filling which requires no cooking, thus eliminating sticky or scorched pans. The Royal Brand Instant Lemon Pie Filling has the texture, color and flavor of old fashioned lemon meringue pie.

• • •

Beckman Instruments, Inc., is producing a pocket-size pH meter featuring a single electrode, a combination of the reference and glass electrodes. The instrument has a "memory" dial for use in standardizing and a pH range of 2 to 12; it operates from batteries of the type used in hearing aids.

The low-priced pH meter, to measure acidity and alkalinity, is accurate, dependable and easy to operate. It can be used in agricultural and soil research and testing, food processing, metal finishing

and plating and in chemical and industrial research and testing laboratories. It can also be used in school laboratories and in spot checking pH equipment installed in process plants.

Further information may be obtained by writing Scientific Instruments Division, Beckman Instruments, Inc., Fullerton, Calif.

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Recently published literature is offered by Brinkmann on their Sartorius and other precision instruments, listed with identifying section number and sheet number for reference: "Projecta" analytical projection balance, three models (Section A, sheets 3-6); balance table for elimination of vibration and shocks (Sec. A, sheet 15-16); speed balance for determination of specific gravity of solids (Sec. A, sheet 11); line operated research pH meters (Sec. D, sheets 9-10); Metrohm Coulometer (Sec. D, sheets 11-12); Elphor equipment for paperelectrophoresis and chromatography (Sec. D, sheets 15-18); Elphorecorder – automatic paperstrip scanner and integrator (Sec. D, sheets 19-20); Chromatopart–automatic fraction collector (Sec. D, sheets 23-24); electrically heated vacuum drying apparatus for preparation or drying of medium-sized and small samples for analytical purposes (Sec. D, sheet 25); Polarecord–highly compact apparatus for polarography and amperometric titrations (Sec. D, sheet 30); additional Ipscaphot exposure meters and accessories (Sec. E, sheets 2-9); new laboratory aids – Cyclotherm, universal water thermostat; automatic dispenser for rapid delivery of exact amounts of liquid; Mergotherm, constant temperature circulator (Sec. D, sheet 21); and preliminary information on a 16mm micro motion picture assembly for normal and time lapse exposures. White: C. A. Brinkmann & Co., 378-380 Great Neck Road, Great Neck, L.I., N.Y.

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A new line of nonhazardous sprays and spray concentrates for industry and for grain protection, especially formulated with pyrethrins and activators, is announced by Larvacide. The line includes L-P Industrial Spray, a knockdown oil-base spray for general-purpose use; Servacide, effective against hidden insects because of enhanced vapor irritant action; L-P Mist Concentrate for fog and mist blowers; and Larva-Tectant for long-time protection of grain against insect infestation. For free descriptive literature write: Larvacide Products, Inc., 117 Liberty St., New York 6, N.Y., or 1515 3rd St., San Francisco, Calif.

### . . . Patter

The 23 midwest sections of the American Society for Quality Control met October 11 and 12 in the Hotel Leamington, Minneapolis, Minn.

Three nationally-known educators conducted the program—N. H. Barnard, chairman, Department of Mechanical Engineering, University of Nebraska; I. W. Burr, Department of Mathematics, Purdue University; and J. A. Henry, Department of Mechanical Engineering, University of Illinois.

On the first day, leaders in quality control from government and industry spoke on 15 different subjects. On Friday, Professors Barnard, Burr and Henry spoke on the topics of variation, process control techniques, probability and acceptance sampling.

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Dow Chemical has purchased two 2-million-volt Van de Graaff particle accelerators, manufactured by High Voltage Engineering Corp., Cambridge, Mass., for basic studies in radiation chemistry. This will make three super-voltage units in use by the Dow company. One of the new machines will be installed at its radio-chemistry laboratory in Midland, Michigan, for irradiation of plastics and chemicals; the other in the company's Western Division research laboratory in Pittsburg, California.

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Industrial Bio-Test Laboratories, Inc., Northbrook, Illinois (a Chicago suburb), announce completion of new industrial toxicology laboratories to provide comprehensive biological evaluations at a time when new materials and chemicals are creating problems in public health. "Industry wishes to safeguard the health of individuals coming in contact with these new materials," says Dr. Joseph C. Calandra, Bio-Test President. "The laboratories offer industry a practical solution to toxicity and related problems through study of the new substances."

Facilities are provided for evaluating the physiological and toxicological properties of chemicals on all forms of living organisms; accommodation for small and large experimental animals; laboratories for radioisotope studies and chemical research, for inhalation studies and air pollution research, and for work with bactericidal and fungistatic chemicals; balanced aquaria to aid in studying effects of water pollution on fish and other marine life. A greenhouse for studying agricultural chemicals and residues is to be added this fall.

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The formation of Comco Co., manufacturers representatives and brokers in the food and related fields, is announced by Clint Cregier, L. A. Mackenroth, B. J. McAuliffe and C. M. O'Malley.

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The first meeting of the International Association for the Assay and Evaluation of Cereal Products will take place December 5 in Vienna, Austria. Chairman will be Dr. E. Maes, professor of cereal chemistry at the College for Industrial Fermentations, Ghent, Belgium.

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Detmold, Germany, was the meeting place of a convention September 10 to 12 of the (European) Association of Cereal Research, dealing with problems in the manufacture of bread, crackers, and biscuits. Judging by word received in advance of the convention, the program was an excellent one. Eminent authorities participated and the range of subjects was comprehensive.

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Also meeting in Detmold October 10 to 12 is the annual milling convention of the Association. The preliminary program includes the main topics of grain quality, milling technology, and automation. W. R. Schaefer, who was a member of the panel on world dietary problems at the AACC annual meeting in New York this year, has a prominent part in the program. Forum discussions will follow the main addresses.

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A new catalog illustrates and describes items needed for accurately analyzing the amount of moisture in any solid, granular, liquid, or semi-liquid material: moisture tellers, speed ovens, speed dessicators, and accessory items. Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, Mich.

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New bulletin is offered on Sprout-Waldron's package unit pneumatic conveyor "Airo-Flow"; describes new model vacuum system for car and truck unloading, also used as pressure system for general material transfer. Ask for Bulletin 154, Bulk Materials Handling Div., Sprout-Waldron & Co., Muncy, Pa.

## A.A.C.C.

# LOCAL SECTIONS

The sixth annual trans-border meeting of Niagara District no. 8, Association of Operative Millers, Toronto Section no. 11 and Niagara Frontier Section no. 6, A.A.C.C., was held Saturday, October 13, in the Royal York Hotel, Toronto, Canada.

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The Nebraska Section no. 4 will meet November 24 in Lincoln, Nebraska. D. W. Conrad, General American Transportation Corporation, will speak on Bulk Transportation, B. D. Crissey, Crissey Company, on Bulk Storage Bin Equipment or Pneumatic Flour Handling and Robert Joslin, Fairmont Foods, on Rheology of Doughs and Leavening.

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The annual A.A.C.C. Tri-Section meeting was held October 5 and 6 in Manhattan, Kansas. Participating sections were Pioneer Section no. 2, Kansas City Section no. 3 and Lone Star Section no. 10.

At a smorgasbord in the Terrace Room of the Wareham Hotel on Friday, H. E. Jones, director, Kansas Extension Service, spoke on the subject The Second Mile in Kansas Agriculture.

On Saturday, four speakers presented papers for a symposium on ionizing radiation of foods. They were R. H. McFarland, Professor of Physics, Kansas State College; Kenneth Gilles, General Mills, Incorporated, Minneapolis, Minnesota; Charles S. McWilliams, Quartermaster Research and Development Command, Chicago, Illinois; Max Milner, Department of Flour and Feed Milling Industries, Kansas State College.

At a Saturday luncheon in the Kansas State Union Building, Lawrence Zeleny, A.A.C.C. president, and other national officers of the association, presented a discussion of association affairs.

A more complete report on the meeting will be published in a later issue of Cereal Science Today.

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The following persons have been elected to the offices indicated, for the 1956 to 1957 term, by Central States Section no. 5: Chairman, W. O. Edmonds; Vice-chairman, John H. White; Secretary-Treasurer, Herman Sausselle.

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Canadian Prairie Section no. 14 has published its annual report of the year's activities. Prepared by Edwin J. Bass, Secretary-Treasurer, the report includes abstracts of papers presented, minutes of the annual business meeting, a chairmans' report and the secretary-treasurer's run down of attendance, membership and financial position.

Six papers were presented at the five meetings by I. Hlynka, G. N. Irvine, C. B. Davidson, D. G. Hamilton, F. R. Forsyth and Werner Schaefer of the Federal Cereal Research Institute, Detmold, Germany.

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Northwest Section will hold a luncheon meeting Friday, November 30, at twelve noon in Dayton's Skyroom. Norman Foster, chief chemist for the Minneapolis office of the Food and Drug Administration will speak on the subject "Wheat Sanitation Standards". The subject is particularly significant because in July the Food and Drug Administration tightened cleanliness requirements for wheat used in manufacturing.

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Midwest Section met November 5 at the Builders Club in Chicago to hear addresses by William C. Roth, Bread Production Manager for American Bakeries Company, and William Hanks, technical service representative for Durkee Famous Foods.

Roth discussed new mechanical developments in wholesale bread bakeries; and Hanks spoke on new principles in the biscuit and cracker industry. Hanks supplemented his remarks with a motion picture of various cookie machines in operation together with a description of their operating principles.

# OVERSEAS REPORTS

### . . . France

The annual general meeting of the International Milling Association was held on May 29 and 30 in Paris. The conference was opened by President H. J. de Koster, Holland. More than 50 delegates of the milling industry, of twelve countries of Europe, attended the meeting to discuss milling problems, the wheat market, and the nutritive value of flour and bread in the diet. The meeting was an excellent contribution to understanding between the milling industries of the member countries.

Papers were presented by W. Schäfer, of the Federal Research Institute for Cereal Conversion, Detmold, Germany, on "The evaluation and standardization of bread grain"; C. L. Copeland, Director of Public Relations, the National Association of British and Irish Millers, England, on "What are public relations?"; and Mr. Jacquot, Director of the Biochemistry and Nutrition Laboratory, National Institute of Scientific Research in Paris, on "The present problem of bread consumption in France."

Mr. Lucien Brisson, President of the National Association of French Milling in Paris, is the General Secretary of the International Milling Association.

The general meeting of next year will be held for the first time at Folkestone, England, in May.

JEAN BURE

### . . . The Netherlands

Four Dutch grain experts have returned from a trip to Canada, on invitation of the Canadian Wheat Board. Points visited included installations for handling and storing grain, research laboratories, and farms in Vancouver, Calgary, Regina, Winnipeg, Churchill, Fort William-Port Arthur, Toronto, Ottawa, and Montreal. A cordial welcome was extended by the Committee of the Wheat Board at the Grain Exchange in Winnipeg.

The members of the mission were: T. P. Huisman, President of the Dutch Central Board of Agricultural

Products; J. S. Brandsma, one of the Directors of the Board; G. Boschloo, Director of N. V. Meelfabriek "De Korenschoof," Utrecht; and L. A. L. v.d. Lande, Director of the Kon. Ind. Mij. v/h Noury & v.d. Lande, Deventer.

G. L. BERTRAM

### . . . Australia

In the early 1930's there was considerable interest, within the baking industry of Australia, in starch-reduced bread. Great possibilities were seen for it, provided the manufacture of dry undenatured gluten could be developed. Bakers were at this time "washing" doughs, and the gluten residue was added to straight doughs to fortify the protein content.

Experimental work began in 1935, and success was achieved within a short time. Fielders General Products Pty. Ltd. was formed in 1937 and operations commenced immediately in a shed in Tamworth, producing gluten and wheat starch as basic materials.

The first factory building was erected in 1940. Growth has been consistent, and with additions built in 1945, 1950, and 1954 the plant today occupies nearly five times the space of the original building. Invested capital of £18,000 in 1937 has been increased to £500,000. The company now trades under the name of Wheat Industries (Australia) Pty. Ltd., markets in all States of the Commonwealths of Australia and New Zealand, and exports to the principal countries of the world, its greatest activity being in undenatured dry gluten to the United States and the United Kingdom.

Since production of starch is approximately five times that of gluten, and since wheat starch was unknown for either edible or industrial purposes in Australia at this time, considerable market development and consumer education were necessary. Close liaison with the consumer has been the company's fundamental policy since its inception. Market development has progressed by virtue of the fact that company representatives, with thorough knowledge of the product and an understanding of consumers' methods and requirements, have passed on their "know-how" to plant operators. This technical service has grown from the original search for applications, to market development, and thence to over-all sales administration.

A wide range of specialized starches for edible use and industrial markets is produced, together with modified starches and dextrins.

Of latter years associations with overseas companies have taken place. In 1952 an exchange of technical knowledge with Stein, Hall & Co. of New York was undertaken to develop the starch bonding of corrugated board. In first trials in Australia in 1955, speeds of 520 feet per minute were attained. Market development is still proceeding in this field.

Starch Sugars Refining Co. Pty. Ltd. was formed in 1953 under joint ownership with Duintjer Wilkens Meihuizen & Co. of Holland. This company is now most active in producing liquid and solid glucose from wheat starch.

A need was felt for further technical progress, and arrangements were made in 1954 with Penick & Ford of New York and Cedar Rapids, Iowa, to produce, under license, hydroxyethyl ether derivatives of starch known as Penford Gums. These are already in production in pilot

plant scale proportions.

Recent acquisitions within the Commonwealth were the flour mill of the Great Western Milling Co. Pty. Ltd. last year, and entire ownership of Procera (Australia) Pty. Ltd., originators of patent starch-reduced bread, perhaps the best-known specialty loaf in Australia.

R. A. Bottomley

### . . . England

A Symposium, arranged by the Scottish sections of the Royal Institute of Chemistry, was held June 25–29 at the University of St. Andrews, Scotland. Previous symposia have dealt with developments in the organic chemical industry, in the fermentation industries and in the chemistry of cellulose and its derivatives. It was particularly appropriate that the subject of the present symposium should have been "Recent advances in the chemistry and industrial applications of cereals," because the Presidency of the Royal Institute of Chemistry is held this year by Dr. D. W. Kent-Jones, who attended the conference in his official capacity.

Attendance was well over 100. Overseas visitors included Dr. J. A. Anderson of Winnipeg, Mr. A. P. Dunlop of Chicago, Dr. and Mrs. Bungenberg de Jong (Holland), Mr. and Mrs. Foster (Australia), Mr. Heazlwood (New Zealand), Mr. Pagenstedt (Germany), and Mr. Widke (Sweden). The social side of the event in this ancient University town was well looked after; the happy atmosphere and excellent arrangements were widely praised by those attending the Symposium.

Question and answer periods greatly enhanced the generally high value of the papers. Dr. G. D. H. Bell (Cambridge) and Dr. J. A. Anderson (Winnipeg) each described their applications of methods of testing new wheat varieties. Dr. Anderson also discussed barley testing (malting equipment) and semolina testing in macaroni manufacture. Dr. Amos (London) described the essentials of flour milling processes and discussed special types of flour, particularly self-rising. Miss R. Bennett (Chorleywood), in the absence of Dr. Coppock in Australia, compared the Chopin and Brabender dough-testing equipment with the "Research" apparatus developed by Dr. P. Halton. In testing improver-treated bread flours it is essential (a) that the dough receive a preliminary molding, a feature absent from the normal Chopin procedure, and (b) that yeast-fermented doughs be employed as in the normal use of the "Research" apparatus. The described modifications of technique aimed at securing better alignment of results between the three forms of apparatus, and also an improved method of using the Farinograph (on fermented dough) for water absorption determination.

Dr. J. Hawthorne (Royal Technical College, Glasgow) gave an outstandingly interesting review of various modern methods of analysis applicable to cereal problems, including various types of chromatography, countercurrent separation, spectrophotometry (u.v. and i.r.), polarography, electrophoresis, ultracentrifugation, and raidoactive tracer methods. Marked interest was also shown in a lecture by Prof. I. A. Preece (Heriot-Watt College, Edinburgh), describing the carbohydrate contents of various cereals and reviewing changes occurring during malting, with particular reference to polysaccharides, especially hemicelluloses.

Dr. E. M. Widdowson (Cambridge) read a paper by Prof. R. A. McCance and herself, reviewing the historical aspect of brown and white bread and giving new thoughts on various deficiency diseases, especially those connected with cassava and maize.

Another outstanding paper was that of A. P. Dunlop (Quaker Oats) on uses of furfural, prepared initially from oat husks. Drs. J. J. C. Hinton and N. L. Kent of the Cereals Research Station (St. Albans) discussed, respectively, their work on dissection and composition of grain with special reference to the distribution of nutrients within the grain, and on recent oatmeal research.

Dr. R. A. Scott (Henry Simon Ltd.) described recent developments in automatic control of machinery in flour mills, biscuit factories, etc., and in bulk delivery of flour, especially pneumatic conveying.

Shortage of space, certainly not reflection of any lack of interest aroused, must preclude further discussion of lectures also given by:

"The history of cereal growing in Scotland," Mr. G. A. Catto (Edinburgh and E. Scotland College of Agriculture); "The breeding of barley for malting," Mr. D. O. Williams (Guiness, Dublin); "The effect of fertilizers on the yield and composition of cereals," Dr. G. W. Cooke and Mr. H. V. Garner (Rothamsted); and "Cereals in animal nutrition," Dr. J. Duckworth (Rowett Research Institute).

It was agreed by all participants that this was a particularly useful Cereal Conference, the caliber of the papers presented and the ensuing discussions having reached generally a very high standard.

C. R. Jones

# the President's Corner

## news of the association

### ANNUAL CALL FOR MANUSCRIPTS

As you know, the 42nd annual meeting of A.A.C.C. will be held May 19 to 23, 1957, in the Sheraton-Palace Hotel, San Francisco.

On behalf of the Program Committee I would like to invite all members to prepare technical papers for presentation at the meeting. I feel certain there are many of you who could make valuable contributions.

However, because of the distances involved, you must submit exact titles of your papers by January 21, and abstracts by March 4, to the chairman of the committee whose area of responsibility includes your subject, or to the Program Committee Chairman. The names of the committee chairmen, their addresses and areas, are as follows:

Mark A. Barmore, Western Wheat Quality Laboratory, Agricultural Experiment Station, Pullman, Washington—Cereal Production (including Breeding, Cropping Practices, and Variety Testing) and Storage; Welker G. Bechtel, American Institute of Baking, 400 East Ontario St., Chicago 11, Illinois—Soft Wheat Flour Products (including Pre-mixes), Non-flour Ingredients, Flavor; and Wilbur S. Claus, The Carnation Company, 8015 Van Nuys Blvd., Van Nuys, California—Nutrition, Prepared Cereals, Industrial Non-food Uses.

Other committee chairmen and their areas, are Robert A. Larsen, Research and Development Dept., Pillsbury Mills, Inc., Minneapolis 2, Minn.—Flour Milling, Wheat and Flour Composition, Physical Testing; William W. Prouty, American Stores Company, 59th and Upland Way, Philadelphia, Pa.—Baking, Fermentation, Freezing, Packaging; Gaylord P. Whitlock, Chemical Division, Merck and Co., Rahway, New Jersey—Feeds, Analytical Methods.

The Program Chairman may be addressed as follows: Dale K. Mecham, Western Utilization Research Branch, U.S.D.A., Albany 10, California.

Dale K. Mecham

# BOOK reviews

**Soil Zoology,** ed. by O. Keith McE. Kevan. 512 pp. Academic Press Inc., New York, 1956. Price, $10.00. Reviewed by A. C. HODSON, University of Minnesota.

This book of 512 pages is a collection of papers read at the Second Easter School in Agricultural Science organized by the University of Nottingham School of Agriculture. These Proceedings are not intended to provide a complete textbook on the subject, but are complete enough to give an excellent picture of the present state of knowledge concerning soil zoology and the methods for study in this field.

The contributions are arranged in two principal sections. One consists of a group of introductory papers on pedology and ecology and a series of papers on soil relationships of important groups such as insects, nematodes, earthworms, protozoa, and zoophagous fungi. The other includes a variety of papers which describe methods of sampling soil organisms of all types, and the preparation of collected material for study. Special emphasis is placed on new methods of sectioning soil samples to observe the undisturbed texture of soils and the microorganisms that they contain.

Following each paper, there is a bibliography and an account of the discussion which took place.

Many American readers will be impressed with the advancements made in a field that has been exploited very little on this side of the Atlantic. The diverse material presented should stimulate interest in the study of soil fauna, and the bibliographies provide a ready means of acquiring background information.

**An Encyclopedia of the Chemical Process Industries,** by Jeffrey R. Stewart; 820 pages. Chemical Publishing Co., Inc., New York, 1956. Price, $12.00. Reviewed by R. J. TARLETON, This Journal.

This book has enjoyed several editions as well as several titles. First published in 1940 as *National Paint Dictionary*, it saw its fourth edition published as *Stewart's Scientific Dictionary*. Now the author has changed publishers and name.

As stated in the editor's note, both author and publisher felt the work was not a scientific dictionary but rather a reference book, and this is quite true. It treats raw materials, processes, equipment, and finished products of the chemical process industries in an encyclopedic form. It also lists definitions of technical and scientific terms which are frequently encountered in these industries. The multitude of trade-name and trademark products included should be extremely useful as a buyer's guide for chemists.

While *An Encyclopedia of the Chemical Process Industries* contains few references to the field of cereals or cereal by-products, it can be recommended as a useful adjunct in the research library since it will enable the food chemist to obtain, easily and quickly, pertinent information on an allied field.

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**Advances in Food Research,** Vol. 6, edited by E. M. Mrak and G. F. Stewart. xii + 398 pp., author and subject indexes. Academic Press, Inc., New York, 1955. Price $9.00. Reviewed by DONALD K. TRESSLER, Quartermaster Food & Container Inst., Chicago.

This volume contains seven comprehensive review articles, each written by a well-known specialist in the particular field reviewed, covering: 1) applications of research to problems of candy manufacture; 2) bacterial spoilage of wines, with special reference to California conditions; 3) microbiological implications in the handling, slaughtering, and dressing of meat animals; 4) microbiological problems of frozen food products; 5) potato granules, development and technology of manufacture; 6) thermal destruction of Vitamin $B_1$ in foods; and 7) tunnel dehydrators for fruits and vegetables.

Of particular interest to the cereal chemist is the review by K. T. H. Farrer of Kraft Foods, Ltd., Melbourne, Australia, on thermal destruction of vitamin $B_1$ in foods. Farrer reviews studies of approximately twenty research workers on losses of thiamine which occur when bread is baked and/or toasted and during cooking of breakfast cereals. Losses of thiamine during cooking of cereals and baking of bread and hot breads are compared with those during cooking and heat processing (canning) of vegetables, meat, and poultry.

Also of interest to the cereal chemist and food technologist is the review by G. Borgstrom, Swedish Institute for Food Preservation Research, Göteborg, Sweden, of problems of sanitation encountered in food freezing plants.

*Advances in Food research* can be recommended to all those who want the best books in the food technology field.

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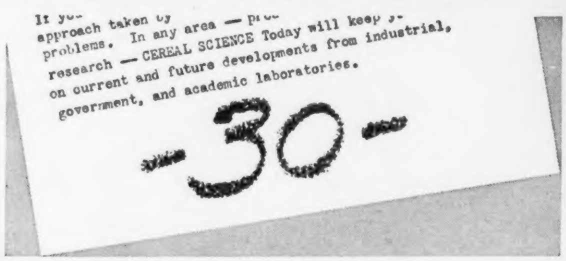
**Briefly Noted . . .**

*Methods of Biochemical Analysis*, Vol. 3, ed. by David Glick. Interscience Publishers, New York, 1956.

*Advances in Enzymology*, Vol. 17, ed. by F. F. Nord. Interscience Publishers, New York, 1956.




## SECTION CERTIFICATES

At the New York meeting last May, President Cathcart announced that all Local Sections of the A.A.C.C. which adhered to the national constitution would receive a certificate of affiliation. These certificates have been presented to the Local Sections by our national President, Dr. Lawrence Zeleny. It was during one of these presentations that the origin of the Pioneer Section came to light.

As the story goes, a group of cereal chemists in the Kansas area got together to discuss their mutual problems and formed in 1922 the Chemists' Round Table Club of the Kansas Millers' Club. This group maintained an informal association that interested itself largely with analytical problems of the laboratory. In fact, in July of 1924 the club inaugurated a system of monthly check samples not unlike the National Check Sample of the A.A.C.C. today. In 1926, this group met in Newton, Kansas and decided to affiliate with the A.A.C.C. However, a group of cereal chemists in the Minneapolis area beat them to the draw and received certificate No. 1. This group is known as the Northwest Section. To compensate for this loss, the Kansas group decided to call themselves the Pioneer Section to let one and all know that they were the first regardless of Section number.

## NEXT MONTH

In the December issue we're going to feature two papers presented at the New York meeting. The first is by J. R. Couch of the department of Biochemistry and Nutrition, Texas A & M College and it discusses "Micronutrient Problems in Feed Formulation". The second paper by E. Maes describes current cereal research in Belgium. In addition we will have an authoratative report from one of our British correspondents on the recent Dublin Yeast Symposium.

## JOHN H. PARKER

Just as we were about to go to press we heard the sad news of the death of Dr. John H. Parker, 65, Director of the Malting Barley Improvement Association, Milwaukee, Wisconsin. He was an authority on plant research.

As Director of the Malting Barley Improvement Association since its founding in August, 1945, he encouraged the production of barley suitable for the malting industry particularly in the states of North Dakota, Minnesota, Montana, South Dakota, Illinois, Michigan, Wisconsin and Iowa. He was widely known in these states because of his many trips and talks made in connection with the malting barley improvement program. Dr. Parker also made trips to the barley growing areas of western United States and Canada to study barley breeding and production and to encourage the production of acceptable varieties of malting barley. He had a keen interest in research and worked constantly in the interests of increased research on malting barley, especially the breeding of new improved varieties.

Before coming to Milwaukee, Dr. Parker was Director of the Kansas Wheat Improvement Association from 1938 to 1945 and Professor of Plant Breeding at Kansas State College, Manhattan, from 1917 to 1938.

Dr. Parker was born in St. Paul, Minnesota, August 13, 1891. He received a Bachelor of Science degree from the University of Minnesota in 1912, a Master of Science degree from Cornell University, Ithaca, New York, in 1916, and a Doctorate degree from Cambridge University, England, in 1928. During his studies he specialized in plant breeding and research.

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